HOUSE OF COMMONS Session 1992–93

SCIENCE AND TECHNOLOGY COMMITTEE

First Report

THE POLICY AND ORGANISATION OF THE OFFICE OF SCIENCE AND TECHNOLOGY

Volume 2: Minutes of Evidence and Appendices

Ordered by The House of Commons *to be printed*
10 December 1992

LONDON: HMSO
£27.30 net

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HOUSE OF COMMONS Session 1992–93

SCIENCE AND TECHNOLOGY COMMITTEE

First Report

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The Science and Technology Committee is appointed under SO No. 130 to examine the expenditure, administration and policy of the Office of Science and Technology, associated public bodies and similar matters within the responsibilities of the Secretary of State for Northern Ireland.

The Committee consists of a maximum of eleven members, of whom the quorum is three. Unless the House otherwise orders, all Members nominated to the Committee continue to be members of it for the remainder of the Parliament.

The Committee has power:

(a) to send for persons, papers and records, to sit notwithstanding any adjournment of the House, to adjourn from place to place, and to report from time to time;

(b) to appoint specialist advisers either to supply information which is not readily available or to elucidate matters of complexity within the Committee's order of reference;

(c) to communicate to any other such committee and to the Committee of Public Accounts its evidence and any other documents relating to matters of common interest; and

(d) to meet concurrently with any other such committee for the purposes of deliberating, taking evidence, or considering draft reports.

The following were nominated members of the Committee on 13 July 1992:

Mr Spencer Batiste
Dr Jeremy Bray
Mr Malcolm Bruce
Mrs Anne Campbell
Cheryl Gillan
Mr William Powell
Sir Giles Shaw
Sir Trevor Skeet
Dr Gavin Strang
Sir Gerard Vaughan
Mr Alan W Williams

Sir Giles Shaw was elected Chairman on 15 July 1992.

On 9 November 1992 Mr Malcolm Bruce was discharged and Mr Andrew Miller added to the Committee.

On 16 November Dr Gavin Strang was discharged and Lynne Jones added to the Committee.

The cost of printing and publishing this Report is estimated by HMSO at £38,975.
The cost of preparing for publication the shorthand minutes of the evidence taken before the Committee and published with this Report was £3,369.59.

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The Agricultural and Food Research Council

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Confederation of British Industry

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Mr Ian Cooper—Chief Executive, BHR Group Ltd and
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Engineering Employers Federation

Paul Lester—Chief Executive, Graseby Plc and
Professor David Balmford—Chief Scientist, Westland Helicopters Ltd

CHEMICAL INDUSTRIES ASSOCIATION

Dr John Brophy—General Manager Corporate Research, BP Chemicals Ltd,
Dr Michael Caton—Director Scientific Relations, Rhône-Poulenc Ltd and
Mr Doug Rodger—Executive Director, Business Development, CIA

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The following submitted memoranda and associated papers which have been reported to the House, but not printed; copies have been placed in the House of Commons Library, where they may be inspected by Members. Other copies are in the Record Office, House of Lords, and are available to the public for inspection. Requests for inspection should be addressed to the Record Office, House of Lords, London SW1 (tel. 071-219 3074). Hours of inspection are from 9.30 am to 5.00 pm on Mondays to Fridays.

1. James Bentley, CEng, FIMechE, Managing Partner of KPMG Management Consulting.
2. Centre for the Exploitation of Science and Technology.
3. Advisory Council on Science and Technology.
4. Advisory Board for the Research Councils.
5. Confederation of British Industry.
6. Association of Medical Research Charities.
7. Higher Education Funding Council for England.
8. UK Industrial Space Committee.
9. British Association of Remote Sensing Companies.
10. Economic and Social Research Council.
11. Science and Engineering Research Council.
12. Committee of Vice-Chancellors and Principals of the Universities of the UK.
13. Welsh Funding Councils.
14. Council of Science and Technology Institutes.

MINUTES OF EVIDENCE

TAKEN BEFORE THE SCIENCE AND TECHNOLOGY COMMITTEE

MONDAY 26 OCTOBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste	Mr William Powell
Dr Jeremy Bray	Sir Trevor Skeet
Mrs Anne Campbell	Dr Gavin Strang
Cheryl Gillan	Mr Alan W Williams

Memorandum submitted by the Office of Science and Technology

STAFFING

The Office of Science and Technology is part of the Office of Public Service and Science (OPSS) within the Cabinet Office. OST has 89 staff, of whom 23 serve in the secretariats of the ABRC and ACOST. The numbers in each grade are as follows:

	Total	Of which ACOST/ABRC
G2	2	1[1]
G3	3	1
G5	5	1
G6	8	2
G7	18[2]	5
SEO	1	0
HEO/HEO(D)/HSO	12	3
EO	10	2
AO	9	2
AA	4	1
SPS	3	0
PS	10	4
Typist	4	1
Total	89	23

Figures as of 30 September 1992

[1] Sir David Phillips, Chairman of ABRC, is not a Civil Servant but his remuneration is related to that of the Civil Service Grade 2.

[2] One Grade 7 on loan to the LINK Secretariat.

2. The creation of OST brought together the former Cabinet Office S&T Secretariat and the Science Branch of the then named Department of Education and Science (DES), with the DES staff transferring to the Cabinet Office with the responsibilities transferred in the Transfer of Functions (Science) Order 1992. ACOST and ABRC continue to act as independent advisory bodies, with the support of secretariats staffed by OST.

3. The tasks performed by members of OST are described in the Annex, the current structure largely reflecting responsibilities prior to the creation of OST. The eventual organisation and staffing of OST will depend on the policies that will be set out in the White Paper planned for the first half of 1993, but in the interim a deliberately limited reorganisation is in hand to create two commands—one covering S&T issues (domestic and international) which cut across Government Departments, and the other covering the science base, the science budget and the Research Council system. Within this overall structure, action teams are being formed, bringing together people from both commands, to take forward priority OST issues such as the planned White Paper on S&T, and S&T aspects of the EC Presidency.

4. There have been no significant changes in staffing levels since the creation of OST. However, five additional staff are being brought in on a short and fixed term basis to conduct a study on the allocation, management and use of the public funds devoted to S&T.

CO-ORDINATION ACROSS GOVERNMENT DEPARTMENTS

5. Science and Technology across Government is co-ordinated principally through the Cabinet Committee on Science and Technology, chaired by the Prime Minister. The Chief Scientific Adviser is in attendance. It is supported by an Official Committee, chaired by the Chief Scientific Adviser and attended by Chief Scientists and senior officials from Departments with significant S&T interests. In addition, OST has a standing responsibility to co-ordinate Government activity in the field of S&T and OST officials maintain close links with counterparts in other Departments, attending other Departments' committee and

advisory group meetings and co-operating in reviews and assessments. This liaison is helped by the practice of filling a number of OST posts with staff on loan from other Government Departments, Research Councils and other organisations. OST also provides an overview of the S&T effort across the public sector through the publication of the Annual Review of Government Funded R&D.

6. The creation of OST is designed to reinforce the changes announced in the 1987 White Paper (Cm 185, Ref 1) to create a capability at the centre of Government for considering S&T issues—through collective Ministerial consideration, under the Prime Minister's leadership, of S&T priorities and by the establishment of ACOST. The White Paper will consider how OST might best contribute towards the strengthening of the UK's S&T capability, learning from the lessons of the machinery which has been in place over the past five years.

CHIEF SCIENTIFIC ADVISER'S ROLE IN PES

7. In 1991, the Prime Minister invited the Chief Scientific Adviser (CSA) to advise Treasury on the Science and Technology components of the bids submitted by Departments as part of the Public Expenditure Survey. Having studied the S&T bids, and after discussion with individual Departments of the argument supporting their bids, the CSA provided advice to the Chief Secretary and the Prime Minister on the balance of expenditure between different areas, and on the total for Government expenditure on S&T.

8. In the rather different context of the present survey arrangements, the Chief Scientific Adviser has once again provided advice to the Chief Secretary on the value for money and scientific merit of the proposals for future spending on S&T.

ANNEX

OFFICE OF SCIENCE AND TECHNOLOGY

HEAD OF OFFICE:	PROFESSOR W D P STEWART, FRS, FRSE Chief Scientific Adviser	
DIVISION A		
HEAD OF DIVISION	GRADE 3	R FOSTER
Whitehall co-ordination of policy on domestic science issues (outside the Science Base); Whitehall co-ordination of EC policy and attendance at EC Council of Research Ministers/CREST/Research Group		
DIVISION B		
HEAD OF DIVISION	GRADE 3	D A WILKINSON
General policy for the Science Base including EC and other international collaboration; Policy for and management of the Science Budget		

Six members of staff offer direct support to Professor Stewart, Mr Foster and Mr Wilkinson.

DIVISION A		
HEAD OF DIVISION	GRADE 3	R FOSTER
Branch 1		
Whitehall co-ordination of policy on domestic science and technology issues (outside the Science Base) including Intellectual Property/Generic Technologies/Environment/Biotechnology; Next Steps Agencies/Internal Market; ED(S)(0); CEST; Technology Transfer; responses to ACOST reports; Parliamentary Select Committees; R&D/S&T statistics.	GRADE 5	DR D P WALKER
Branch 2		
Whitehall co-ordination of EC policy; attendance at EC Council of Research Ministers/CREST/Research Group; EC Joint Research Centre; COST; Bilateral contacts on EC policy issues; cross-Government co-ordination of non-EC bilateral/multilateral contacts; Co-ordination of OECD activities including CSTP; UN Strategic analysis on S&T.	GRADE 5	D A WARREN

In Branch 1 Dr Walker is supported by 13 staff; in Branch 2 Mr Warren is supported by eight staff.

DIVISION B		
HEAD OF DIVISION	GRADE 3	D A WILKINSON
Branch 1		
Science Base EC and other international collaboration; International Scientific Organisations (basic science); Territorial responsibility for SERC, Royal Society and the Royal Academy of Engineering; Publicity for science and promotion of its greater understanding.	GRADE 5	R P RITZEMA
Branch 2		
General policy for the Science Base structural issues; research in Higher Education and dual support; Bioethical matters; Scientific manpower; performance measures for the Science Base; Inter-disciplinary Research Centres; Territorial responsibility for ABRC, AFRC, ESRC and MRC.	GRADE 5	DR J PARTINGTON
Branch 3		
Policy for and management of the Science Budget; Value for money in the Science Budget; Operation of the Resource Management Arrangements (RMA); Environmental matters; Territorial responsibility for NERC.	GRADE 6	DR K D J ROOT

In Branch 1 Mr Ritzema is supported by seven staff; in Branch 2 Dr Partington is supported by 10 staff; and in Branch 3 Dr Root is supported by eight staff. All three Branches are served by a support unit of six staff.

Advisory Board for the Research Councils

	CHAIRMAN	SIR DAVID PHILLIPS, KBE, FRS
BOARD SECRETARY	GRADE 3	DR D G LIBBY
Forward Look and PES Links with HE Research Council System Supercomputing Territorial: AFRC/NERC	GRADE 7	DR J ADAMS
Manpower Information Systems Evaluation Secretariat Arrangements Territorial: ESRC/Royal Society/RAEn	GRADE 7	MS A FROST
Strategy Document Economic Arguments for Science Funding Technology Transfer Territorial: SERC	GRADE 7	DR P LLOYD
International Issues Science Policy Studies Relations with OGDs Territorial: MRC	GRADE 7	DR A WILLIAMS

There are an additional seven members of staff in support.

Advisory Council on Science and Technology

HEAD OF SECRETARIAT	GRADE 5	DR J McGUINNESS
Environment Emerging and Generic Technologies Human Factors and Organisational Design	GRADE 6	P DALE
International activities Science Base and education	GRADE 6	D SCHILDT
Innovation Advanced Materials White Paper	GRADE 7	D LOBLEY

There are an additional six members of staff in support.

Examination of Witnesses

RT HON WILLIAM WALDEGRAVE, a Member of the House, Chancellor of the Duchy of Lancaster and Minister of Public Service and Science, MR ROBERT JACKSON, a Member of the House, Parliamentary Secretary, Office of Public Service and Science, PROFESSOR WILLIAM STEWART, FRS, FRSE, Chief Scientific Adviser, Office of Science and Technology, MR ROBERT FOSTER, Under-Secretary of State, Office of Science and Technology, and MR DAVID WILKINSON, Under-Secretary of State, Office of Science and technology, examined.

Chairman

1. I open the proceedings by, on behalf of the Committee, welcoming you and your team to this the first evidence session but I must do a little bit more than that, I must welcome the fact you and your Office exist; I must welcome the commendable initiative which this shows in trying at long last to provide a substantial presence for science and technology within Government at Cabinet level, that I think the whole Committee finds extremely refreshing and very challenging. It is to some extent for that reason, and that reason alone, that we are in being and that we have selected the topic we have as our first topic of the Inquiry. So, on all those counts, you are very welcome. If I was to invite you, as I suspect you would wish to, to make an introductory statement before we proceed with our questioning that, too, would be very agreeable.

(Mr Waldegrave) Chairman, may I, first of all, say I am suffering, like a lot of people at the beginning of a new school term, with my children's cold. I apologise and I hope my voice will hold out. I too regard this as a very important moment really for the treatment of science and technology in the House of Commons as a whole. I am happy that I exist but if my existence has been some small part in the events that have led to the setting up of a Select Committee on Science and Technology in the House of Commons, well that has been an important step too. It is an honour to be the first Minister speaking to the Committee. I do not think, Chairman, I want to make a long speech to you other than to reaffirm at this point as you know we have taken the opportunity of the setting up of this new Department to work towards a reformulation of Government science and technology policy in a White Paper next year. It seemed natural to do that with the setting up of the new Office of Science and Technology. I am therefore trying to consult as widely as possible and I am very pleased with the response we have got so far. We have had getting on for 400 responses I think. We have had some very good help incidentally from the media on this matter. I hope other newspapers will not be offended if I mention the Daily Telegraph and Roger Highfield who has carried through a very good consultation procedure for his readers. So there is a real interest. I am still not at the end of the formal consultation period and I am therefore still somewhat in listening mode but that makes it all the more important that your Committee could perhaps contribute to this procedure. That is all I want to say at this stage.

2. Thank you, Chancellor. I think if I may start the questioning and in this section of the questioning perhaps the organisation of the OST and the structure you have set up. Obviously you do have a role which is both original and innovative and on the other side you also have a role which is one of a co-ordinating nature. I think my interest would be to know how you foresee that role. I appreciate this is something which will become encapsulated in the White Paper but there are some doubts expressed that the extent to which your co-ordinating nature or your overview, as I think you have described it, of other Departments which have very substantial science commitments and technological commitments, whether that is of the same character as your other roles? Could you perhaps describe how you think the two roles you have should be developed?

(Mr Waldegrave) Yes. First, Chairman, I think that almost the most important role of all is to be the clear voice of the British Government on behalf of science and technology both here, at home, and abroad, not only in the European Community but very obviously in the European Community in the Research Council. So there is a role which is that of being a voice and a focus of Government activity and of a representative, in so far as Ministers do that, of the public interest on a particular area, a vital area, of our national life. Now, within Whitehall I have two roles but I think they are closely related. First of all, we have attached to us the former DES science budget (a slightly odd phrase but that is what it has always been known as) which is a budget distributed with the advice of the ABRC, the budget of the Research Councils supporting the science base. The Chief Scientific Adviser has always had a role and Bill Stewart, I think it would be fair to say, has developed it very successfully by being the Prime Minister's and the Government's adviser on the totality of the Whitehall R&D effort carried through by the responsibilities of the Ministers, the particular Ministers themselves, but Bill Stewart has advised both the Treasury and the Prime Minister in previous years on the balance of that, not seeking to direct it centrally but to give advice on how it looks. I would not want the OST to surrender that role which is not to say I want to try and direct the science programme to the individual Departments from the centre but I think, both via the official machinery and the Committee machinery which continues to exist—the EDS Committee, which is chaired by the Prime Minister, and the Official Committee which backs that up which Bill Stewart chairs—we would well regard it as an important part of our role to maintain that Whitehall co-ordination. If I can give one example of a decision which has come out of that co-ordination machinery in the past. It was a decision taken in 1985/86 to somewhat

[**Chairman** *Contd*]

move away from the weight of defence R&D in the total mix. Now, we would continue to be involved in such decisions and to take the lead under the Prime Minister in formulating collective policy in that sort of area. Clearly, the details of how we are going to work with other Departments may need some more clarification in the White Paper but what I think I am saying is we need to continue the role that he will fill. I do not think there is any contradiction between that and being the Department responsible for the science budget as such.

Dr Bray

3. Science policy is current business as well as a matter for which you are hoping to review the organisation. In interviews last week the Prime Minister said the Government was concerned with growth and it was reported the Government was examining increases in infrastructure investment. Is R&D part of the infrastructure? Is science and technology an increasing part of the infrastructure assessment?

(Mr Waldegrave) I think even with such an experienced Parliamentarian as you Dr Bray I am not going to get myself in the position of being cross-examined about the PES round before it is announced. When most people talk about infrastructure they talk about capital infrastructure but I think your point is well taken. Human capital is capital too.

4. Can I make the point the question was not to ask that in anticipation of the PES round but to ask whether we may expect to see the results of your work in this year's PES round? You are not waiting while you conduct a year long seminar on organisation?

(Mr Waldegrave) You will *not*, I think, see in *any results* in this PES round any of the sort of broader strategic changes we might want to come to in the organisation or, much more important than organisation, the content of the British science and technology effort. That must await the White Paper. If I try to make any radical shifts in this sort of timescale I would be rightly accused of trying to pre-empt the kind of discussions I have tried to set up in public in terms of the way in which decisions are made in public by the new public expenditure committee, which the Prime Minister set up, I have sat on that Committee and Professor Stewart has given his advice to that Committee.

5. There is a fairly major review of the basic economic strategy underway. Surely science and technology has a major contribution to make to that?

(Mr Waldegrave) I think it has been helpful that our voice has been heard in those difficult decisions relatively clearly because of the new OST.

6. Have you got a staffing structure now which can advise effectively on these current policy issues and on future organisation? The appearance is you have merely shifted the Research Council from the DES Permanent Secretary to another Permanent Secretary, whom you have chosen yourself, and to whom you have subordinated the Chief Scientific Adviser.

(Mr Waldegrave) I would not want to say the Chief Scientific Adviser is subordinated. He has a special kind of character more akin to the Chief Medical Officer of Health, with whom I worked in my old position. He has his own Government-wide responsibility and is accountable to the Prime Minister directly. I do not want to say we have finally settled our own internal organisation structure yet but perhaps Professor Stewart might say a word or two about that. We still, and I make no secret of it, want to bring the teams together in one building and get more integrated working between them. I hope to be able to do that. Perhaps I can ask Professor Stewart to comment on the organisation.

(Professor Stewart) Thank you very much, Chairman. Basically OST was formed by the merger of the old science branch of the DFE and the Science and Technology Secretariat of the Cabinet Office. Once the new OST was set in place it seemed sensible to take stock of where the UK was going on science and technology, and secondly to set in place a structure that would help to underpin that optimally. That was one of the reasons why the Government decided it would have this White Paper, to take stock of the long-term needs and also to have a strategic vision of where it was going. With that in mind it seemed sensible to optimise as best we could the existing structures the resources we had available, take the White Paper through to completion and on the basis of that decide what the infrastructure for the future might be. That is what we are doing.

Chairman

7. We are not expecting, Chancellor, that the White Paper is actually already in concrete and already set. We are expecting to be able to influence it and I am sure that is the purpose of the Committee's inquiry. I hope there will be an opportunity for us to make recommendations as we see fit.

(Mr Waldegrave) There certainly will be. I do not come to this, and I do not believe Bill does or my colleagues do, with a set of proposals already clear in my mind that we want to sell. We all, doubtless, have biases but the discussion is real, the consultation is real.

Dr Bray

8. There is ample precedent in other Departments for somebody other than a Permanent Secretary to be the accounting officer for part of the Departments' expenditure. Who is the accounting officer for the science budget?

(Mr Waldegrave) The Permanent Secretary of OPSS.

[Dr Bray *Contd*]

9. Not the Chief Scientific Adviser? Has the Chief Scientific Adviser any more responsibility for the science budget than he has for defence research?

(Mr Waldegrave) I think it is my responsibility. I would not want to turn the Chief Scientific Adviser, this is my instinct, in the future into such a thing as an ordinary line manager. There is no such thing, some would say, as an ordinary line manager. I think he should be someone a little different myself, but we must consider this further.

Chairman: We will have the opportunity of examining the Chief Scientific Adviser at another stage.

Cheryl Gillan

10. I appreciate you have still got an open mind as you are working up to the White Paper, but in reaching a view on your priorities is it your intention at the moment to build up sufficient expertise within the Department, or will you continue to depend on advisory bodies such as ABRC and ACOST?

(Mr Waldegrave) I am absolutely certain whatever particular structure of advice we settle on we will need external advice. I think it would be a great mistake to try to conduct the science and technology policy with a closed elite, however good they are, because very much what needs to be done needs to be done with the consent of a very wide constituency both in industry and in the universities and elsewhere. I do not think you can really move the science policy in other than ordinary ways except by pretty broad consent, so although I am saying we need not necessarily exactly the structure now, I could not conceive of doing this job without having pretty systematic methods of communication with the science and technology community. My first instinct is that it is, and I shall get into trouble from the Professor, that it is perhaps easier to talk to the science community than the technology community. I welcome the steps being taken to bring together engineers and the steps that have been taken to bring together engineers, but it is of its nature perhaps a more disparate community. We need to take care to make sure we understand what the technologists are saying as well as the scientists.

11. Following on from that, many argue that the advisory bodies consist of the great and the good and are very good at self-perpetuating themselves but new areas in the science and technology field have a hard job getting in on the act. Have you any plans to bring in younger scientists and technologists, either in advisory bodies or in the Department itself?

(Mr Waldegrave) I will ask Bill to say a word about the people working for him and the secondees and his own contacts, which is the real point I think you make. To give an example of a number of recent events, although this does not fully answer your question, for example, the Prime Minister had a reception to which some came the other day in Downing Street, specifically with the advice of the Chief Scientist, which went outside what you might call the usual great and the good, and introduced quite a wide range of young working scientists. That was one occasion but it does symbolise, I hope, that we recognise this issue. It is difficult because when you want committees to take a peer group judgment you have to have the people who carry the peer group weight and it may be by their nature they are going to be more senior people. Perhaps Bill could say a word or two on that.

(Professor Stewart) Can I say, firstly, that about 60% of the people working with us have science and technology qualifications. Most of the others are science and technology literate in that they have worked in Departments which have a major science and technology component. My view about where the scientific expertise lies is quite simply that scientific expertise lies with bench scientists, those working at the bench. I believe we have to make as much use as possible, in a rapidly evolving subject area like science and technology, of inputs from younger groups. I meet informally with groups of younger scientists, and others, in different subject areas on a very regular basis to make sure we know what is going on at their level. In addition to that, we have groups such as ABRC and ACOST. These are skilled practitioners who in the past have played a useful role.

(Mr Jackson) Could I add a point about this very fundamental system on the question of responsiveness of the Research Council and university system to the shifting balance of scientific interest. I think that is a very, very important subject. You need to have responsive systems. As you suggest, one of the best ways of doing that is to influence membership of the relevant executive or advisory bodies. It might be worth inquiring. I have actually seen an analysis in the form of a graph on the shifts which have taken place within Research Councils in terms of funding of different areas of science over the last 10 years. When you see that graphically presented, and I am sure it could be furnished to the Committee, there have been considerable shifts in the pattern of funding relating to different areas as some areas have risen and others have fallen in interest. The picture is not one of static frozen budgets stuck in a pattern. The picture is one of considerable flexibility and responsiveness. It could always be better. There are always going to be problems of catching up with this but the picture is one of considerable change.

Mrs Campbell

12. We have been provided with a helpful memorandum by your Department as part of our deliberations. One of the statements in that memorandum is about the role of the Chief Scientific Adviser. It says he gave advice in 1991 on the value for money and scientific merits of the proposals for future spending on science and technology. My question is really to do with the relationship between the Chief Scientific Adviser and the Chairman of the ABRC and do those roles ever conflict? Do you ever get contradictory advice and if you do whose advice do you take?

[**Mrs Campbell** *Contd*]

(Mr Waldegrave) It has not emerged as yet. Specifically the ABRC, of course, advises on—and its advice has always been followed, as far as I know—the division of the Research Council budget between the Research Councils and Mr Jackson has a lot to do with the way in which that now functions. The Chief Scientific Adviser's remit goes very much wider and he, in particular, last year, I think it is true to say, in the Public Expenditure Round last year, advised the Prime Minister about the overall shape that was emerging from Departments of research and, as I say, in the tough circumstances of this year has again put in advice on these matters. He is, of course, an assessor, I think that is the right word, on the ABRC and I shall now ask him to say whether he has ever differed with Sir David Phillips. That is an unfair way of putting it.

(Professor Stewart) First of all, I used to run a research council. I was a member of ABRC so I know how ABRC operates. In my current post, as Chief Scientific Adviser, I serve as an assessor on it. ABRC is responsible for the advice and allocation of the science budget to the research councils and that is a role I rightly believe is the responsibility of the ABRC. But I keep very close contact with Sir David Phillips, both formally and informally, and our main role in life basically is to try to make sure between us that the monies allocated for science go as effectively as possible to those who can best use it.

(Mr Waldegrave) One of the issues we will have to consider—it is a real issue on which both sides have argued with vigour—in the White Paper is should my Department, i.e. accountable to me, i.e. ultimately Ministers of Parliament, have more to do with the steerage? At the moment we have always handed the money to the scientists and said: "You are the people who know how to deal with this, you are responsible for this" and it has been the peer group system and it has worked pretty well but there are others who say: "Yes, we should have a more national strategy and it should be more accountable to Ministers". That we have to explore.

Chairman

13. That presumably would be an issue which the White Paper ought to illuminate.

(Mr Waldegrave) Yes.

14. This is a big argument which has to be resolved.

(Mr Waldegrave) Yes.

Mrs Campbell

15. I have a follow up question. Is there a case for continuing to have two people advising on different aspects of allocation of scientific funding or do you consider the Chief Scientific Adviser should take over the present role of the chairman of the ABRC?

(Mr Waldegrave) Traditionally, as I said, there have been two quite different functions. There is also a third person: the Chairman of ACOST. Now there is a spectrum here of possibilities and choice. I think one should guard against having too much centralisation but, on the other hand, we are going to want to look at the relationship. I think the way I have been approaching it is to look at the relationship between Ministers and scientists. What are the sort of things Ministers should take decisions about, are there some or is he just fighting for the money?

Mr Batiste

16. Could I look briefly at the two interlocking areas where the Chief Scientific Adviser is involved and see what your perception of his role is, first in relation to the Prime Minister and, second, in relation to the other scientific advisers in Whitehall. Dealing with the access to the Prime Minster point, reorganisation has meant at least in terms of the conventional structure the CSA is one further step removed from the Prime Minister in terms of direct line. I can see the Prime Minister might call for specific advice and ask for the Chief Scientific Adviser to brief him on something. What would be the circumstances, in your view, in which the CSA would seek to exercise the right of access to the Prime Minister?

(Mr Waldegrave) I would make one small alteration to the way you formulated this. I do not regard him as having lost his scientific access to the Prime Minister. I would not feel offended if he said: "This week I feel I should write to the Prime Minister about X. There is a major issue to do here with environmental science or something which it is necessary for me to bring the Prime Minister up to date on". Perhaps that is a bad example.

17. In terms of significant developments, the CSA would see himself in your view as briefing the Prime Minister on things?

(Mr Waldegrave) I would not want to move science further from Downing Street. One of the successes of the structure set up by Lord Zuckerman was he kept a science voice in Downing Street. I do not want to interpose myself in that in any way against that. There is a whole range of Departmental activity which I can do which does not interfere with that. I am here interpreting how Bill would react.

18. Yes.

(Professor Stewart) I am not sure whether I should be sitting here! On day to day affairs I operate via the Chancellor of the Duchy of Lancaster. In the majority of cases that would be the normal route but if there is a time or an occasion when the Prime Minster needs advice from me, he may well seek my advice directly. Equally if I feel it is important to give advice directly to the Prime Minister there is nothing which prevents me from doing that.

19. Can I follow up in that run with something which arose from Dr Bray's question earlier in relation to the Public Expenditure Round this year. In what way would you anticipate you might be

[Mr Batiste *Contd*]

handling your involvement in the round in future years in a different way from the way you are doing it at the moment, having just got set up before the White Paper is established?

(Mr Waldegrave) If the new structure continues, which was set up this year with the EDX Committee, which has been considering public expenditure on which I sit, as we have proceeded so far I (representing the OST) have put certain considerations before them and including advice from the Chief Scientific Adviser. If the Chief Scientific Adviser felt at the end of that procedure that he wished to advise the Prime Minister on the final outcome, I would feel he was perfectly within his legitimate remit to do so.

20. Can I just follow up with the question of the other scientific advisers before we move on. Do you see the Chief Scientific Adviser as being *primus inter pares* among other scientific advisers or something quite separate? Do you feel there is any adequate evolution of the various grades of the scientific advisers that might assist the process in a more structural sense?

(Mr Waldegrave) I have been following this matter in one of the magazines. I do not know whether *primus inter pares* is quite right. He is the Chairman of the Official Committee, are you not? The actual grading, I think I am right in saying your predecessors have been at the grade he is at the moment but none of these things is set in concrete.

Dr Bray

21. Can I ask specifically why you left the Chief Scientific Adviser at the grade 2 post when you are promoting Mr Mottram from a grade 2 in the Ministry of Defence to a grade 1A post when the Chairman of SERC and the Chief Scientific Adviser to the Ministry of Defence are grade 1A?

(Mr Waldegrave) Mr Mottram replaced another man at the same rank as Permanent Secretary of the whole Department and I think that was right. Again I do not myself think that the sort of mechanical grading really represents where the authority of the Chief Scientific Adviser comes from myself.

Chairman

22. I think that may be something he would like to talk about separately.

(Professor Stewart) Could I comment, Chairman. I consider it a privilege and a pleasure to be Chief Scientific Adviser. I am delighted to be in that post, getting paid a salary which is twice what I would get as a university professor. I have no concerns.

Dr Bray

23. I do not think it is a question of salary, it is a question of practical things like why did Ron Oxburgh not attend the Chief Scientific Adviser's meeting until I raised it with the Secretary to the Cabinet?

(Mr Waldegrave) All I can say is Ron Oxburgh has been coming to the meetings.

24. After I raised it.

(Mr Waldegrave) I do not know if it has to do with that or us inviting him. We do call and he does come.

Chairman: We should move on.

Dr Bray

25. I think there are substantial points here. You have the appearance that you have imposed two layers of non-scientists on top of the scientists risking delaying and obscuring the formulation of advice to the Chief Scientist. Should you not be more sensitive to the effect of your role on the scientists and the morale of scientists is the model you set for their role in other organisations?

(Mr Waldegrave) I would just say this really is not a problem but if we build it into a problem it then depresses everyone, it might depress everyone. There is no layer between him and the Prime Minister, he is in exactly the same grade as his predecessors. I have to say these are not very hierarchical people. I do not think this is an issue which should worry scientists. As they have shown in all their representations to us they like the fact he has his own Cabinet Minister, if you like, and he can deploy in the Cabinet and Cabinet Committee and for the first time he is at the centre of the much more powerful science and technology organisation.

26. That may be what the scientists say to you but that is not what they say to us.

(Mr Waldegrave) I have never found the slightest inclination of scientists being polite to Ministers for the sake of being polite to Ministers, any more than do doctors!

Mr Powell

27. Could you tell us what arrangements exist in order to ensure the proper co-ordination between the Higher Education Funding Council and your office and the Research Council?

(Mr Waldegrave) Bill has set up, and I will ask him to describe them, some structures to try and address this which I think is the real danger because with the territorial funding councils there is a danger. Still unified Research Councils, and most of the scientists, are saying to him at the moment they want to preserve that. They do not want to provide Research Councils although there are some minority views. It is essential we should have really careful and consistent ways of co-ordinating the work. Bill has been calling regular meetings involving the personnel involved to address this issue.

(Professor Stewart) Chairman, we are in an interim stage. Now there are three Higher Education Funding Councils there should be similar treatment as far as possible between each of these. Because we are in an interim stage I have set up a series of ad hoc meetings with the chief executives of each of the

[**Mr Powell** *Contd*]

Higher Education Funding Councils and myself to consider together how we can best take the issues forward until the White Paper comes out. I hope that it will address this particular issue.

(Mr Waldegrave) It has got to be watched very closely.

28. Can I take it one step further, and that concerns the danger which there may now be that the quality of research undertaken in the different parts of the United Kingdom may deteriorate as a consequence of the centralisation of responsibility in your office, in particular the liaison between your office and the DFE to ensure this does not happen.

(Mr Waldegrave) I had a big meeting in Scotland with all the heads and the principals and the vice-chancellors and many of the heads of the research institutes in Scotland to address one issue, to see whether they were asking in general for separate Research Councils. On the whole I think it would be fair to say they are not, although there are some dissenters. They thought it important to keep the total UK nature of the Research Council intact as a guarantee of the quality of the science based funding when it comes via that route. It is important to make sure that in different national, or indeed institutional, differences of approach to science, to the provision of their side of the science base from universities, that we understand any differences there might be, which is why Bill has taken the step he has. I do not find expressed to me the fear that maintaining the uniformity of the Research Council base threatens anything, if anything I find some anxiety the other way, about fragmentation.

Chairman

29. Was there not some anxiety about the overlapping nature?

(Mr Waldegrave) You mean the trans-national nature?

30. Yes. You have got five of them and you have an overview of each, or direct responsibility.

(Mr Waldegrave) On the whole—perhaps it was because I was in Scotland where I think Scotland has a good share and does very well in terms of winning Research Council grants, and I am surrounded by Scots colleagues—I have to say that I am open to representations on this if you are getting a strong contrary view. I find there are more anxieties that there would be things lost if we set up separate Research Councils for each nation. There is a minority dissenting view on this, I am aware of that.

Mrs Campbell

31. I want to ask a question about training and the career structure of young scientists. There have been some criticisms from the Royal Society and ACOST about that. Perhaps you would like to comment on that generally?

(Mr Waldegrave) I think it is quite a thorny issue but I think this is one of the things I have got to look at with the help of the universities and perhaps of industry because there has been a considerable growth of people on short-term contracts. There are more people doing science in total but there are more people on short-term contracts with a good deal of insecurity and they are not clear where their future lies. It is easy for me to say because I have not had to do the job, but I do not think we have been very good at pastoral care of relatively young scientists. We have not made it clear what career paths are open to them, who will help them and what the likely period of their doing science is. I think we have to pay more attention to this if we are going to go on getting first rate people at the bottom. It is easier said than done.

(Mr Jackson) I think one of the important ideas that is emerging, which I hope we will be able to pick up and reflect in the White Paper, is one must see the science base in terms of an analysis of its output. One should see it not only in terms of producing ideas and papers and products maybe, but even, most of all, producing people with skills that are useful and appropriate in all sorts of ways. It is the training function of the science base in the Research Councils that has always been recognised but it is not a bolt-on point, it has to be built in from the start. It has to do more about the career paths open to people and how we get people on to those career paths. That is an important emerging topic.

32. Could I make the additional point that I think it is very important to look at the careers of women scientists as well. I think the needs are different and the needs for maternity leave, family leave, perhaps part-time work, have not been taken into account in the present career structure. Certainly lots of women scientists have made the point to me they find it extremely difficult under the existing structures to continue with their work.

(Mr Waldegrave) I agree with that. I have had one meeting with Nancy Lane, who serves on the Citizens Charter Advisory Panel, by good chance, who is a doughty campaigner and gets good success.

33. She is a constituent of mine.

(Mr Waldegrave) I rather share your views. The Chief Scientific Adviser is seeing her tomorrow.

Mr Powell

34. We are delighted you share our concerns that there may be a problem here but can we expect to find, in the White Paper, some solutions to the problem or are you flagging up the fact that there is a problem?

(Mr Waldegrave) I will not have done very well if I have not gone any further by next year. It is not tremendously easy because we are dealing with a wide plurality of employers and sources of employees coming from industry and charities on a short-term basis and one would not want to get into a position of turning that away but I do believe by the judicious use of the mechanism we do have, and by working with universities and industry, because I

[Mr Powell *Contd*]

think some of this is to do with ensuring some of the people we have aged 28, 30 and 32, when they finish their immediate research work, they are of use to industry but it is not very easy.

(Mr Jackson) It is important to recognise it is a subject which is being addressed by the Research Council. There has been a great deal of thinking going on about it which perhaps we will be able to generalise from. Each Research Council is having to think about its policy in respect of studentships and that is for them current business.

(Mr Waldegrave) There are some mechanistic issues, things like portability of pensions, which are interesting if one can get it right.

Mr Strang

35. Before I ask you about spending by other Departments, may I ask you one general question. As a Cabinet Minister for Science and Technology is it your objective to increase the proportion of total Government spending which goes on science and technology?

(Mr Waldegrave) Well, it is certainly my objective to increase the output of science and technology that directly or indirectly feeds back into the growth of the national wealth. I am only answering your question sightly carefully because we have a clear policy which is to say perhaps the R&D spend on defence should be scaled down and we are still on a path to scaling it down. I think I have to say that what I must first address is the quality of value for money, whether we are clear about what the objectives are and whether those objectives are being well met. It would be foolish not to say there is not plenty of good science and technology, we find the more you do the more you can do.

36. Can I put it to you that establishing the Government's overall priorities in relation to science and technology, this is bound to have implications not only for the amount spent on science and technology by individual Departments but also for the important implications for budgets within Departments. If we take a major Department like Defence or Trade and Industry, very big spenders on S&T, by establishing these overall priorities you will be saying something about their overall budget and what they should be spending their money on. Where there are conflicts on that between the Department view and your overall view, how do you see these being resolved?

(Mr Waldegrave) I do not want to move away from the underlying Rothschild customer contractor doctrine in relation to the purchase of R&D by Departments in support of their policy objectives. I think that would be a major setback if you go back to the old days where they were compelled to do that science rather than having proper mechanisms within the Department to ensure that they built in the necessary back-up. Here I am talking about their own policy, the needs of R&D in relation to their own policy, so I do not want to interfere with that. I do think this is one of the options for the kind of nation we can envisage coming about. Perhaps this is one model of how it can work, an interlocutor for them, and we should be a little bit of an examiner of whether the arrangements for purchasing that R&D in support of their own policy objectives are good enough. Some people would say that was a weakness in the years immediately after the Rothschild doctrine was established, that actually the Departments were not strong enough as purchasers of R&D. It might be this is one model of how we might actually relate in this area.

37. May I then ask you about the proposed run down in spending on defence research development which I think you would agree is at a fairly early stage but there has already been, obviously, some evidence of it and some harsh decisions have been taken in relation to individual scientists. Do you see the role of your Department to secure the redeployment of those scientists who otherwise might be lost to the overall scientific effort of the country, to secure their redeployment into other areas of scientific activity and if so what would be the means whereby you would influence this?

(Mr Waldegrave) It is exceedingly difficult—I will ask Mr Jackson to comment on this—to guarantee to actually redeploy those people. I used to work in a big industrial conglomerate and one big scientific part was contracted. It seemed common sense to think people working on torpedoes might move to work on better fridges but they did not, often they left altogether. It is extremely difficult to say: "We guarantee we will redeploy those people." If you ask me would I, as an aspiration, like to see the balance between civil and military R&D in this country shift rather in favour of civil, well that would be my aspiration, yes, but I am being a little careful about saying how you can actually shift those people. I do not think one can necessarily guarantee that.

(Mr Jackson) One can distinguish between financial resources and people. It is difficult to shift financial resources. It is extremely difficult and could cause all sorts of bureaucratic problems if you start focusing on individual people. What happened was a decision was made in 1985/86 to reduce the defence spend on R&D, and it has reduced by 25% since then. In the late 1980s there was a slight uplift to account for expenditure on the European Fighter Aircraft, but basically that policy is on track. In 1988 as a consequence of that policy it was decided substantially to increase the Research Councils' budgets in order to, if you like, have a shift of resources going on there. It is possible to operate the mechanisms like that but I think if you get into an idea of steering investment by creating special bureaucratic structures, I do not believe that would be helpful.

Sir Trevor Skeet

38. We want your Department to be a great success but you have great difficulties. I was reading the evidence given by MAFF,[1] it says where research priorities are largely policy driven as in MAFF it will continue to be necessary for these to be decided by the responsible Department, which means not by you. So I can see collisions coming up there. Reading the evidence of the DTI,[2] they say: "Most of the work is done by inter-departmental co-ordinations" but they do mention, of course, there are certain links which are entirely outside the OST network. Now that is a very very powerful department of the DTI. How do you propose to control them in order to ensure that the overall Government policy is successful?

(Mr Waldegrave) The first quotation you deployed there was of a Department, as I would say, quite correctly standing by the Rothschild doctrine, saying where we are engaged in developing a policy of food safety we should be the customer for good science to enable us to have a well based policy. I do genuinely think it would be a very grave mistake to try to centralise that away from them, for them to have to bid for a central bit of budget to do their policy related plans. Where I think perhaps our formal role should be, we might have some kind of external examiners role in seeing they have the arrangements in place and so on to be able to say: "We were satisfied with how it was all working." MAFF, the Chief Scientific Adviser knows a lot about. The DTI does have an empire, part of which overlaps my Department, part of which is separate. We share the LINK Programme, 50/50. We have a big interest in the technology transfer programme but there is some of that, space for example, that they lead on. Clearly it is important to us, particularly as Britain's space programme, just to take that example, is science led in the sense we are saying we need the applications which feed back into group science as we have an interest in what they do and that is where the inter-departmental co-ordination comes in.

(Mr Jackson) If you take the principle of Rothschild, the Department as customers, there are a number of questions it is possible and appropriate to address and the first is the quality of the processes by which the Department acts as the customer, which the Chancellor has mentioned. Then there is the second question about gaps in programmes, particularly if you look across the whole field in Whitehall where all our separate decisions are taken by departments of customers which is creating a significant gap. There is a role in identifying those gaps and trying to do something about them. There is also the issue of synergies, whether it is possible to control programmes taken separately by customers in a way that maximises the benefits of these new benefits. There is an overall view that it is possible to have that if you look at the whole ensemble of Government policies, what is happening in the universities and in industry.

39. Chancellor, overall control on a loose rein is going to mean departments are going to get away with a number of things where they should be restrained. The pharmaceutical industry is probably one of the most powerful in the Community and that comes under the Ministry of Health, it may be there your control is entirely indirect and you may have limited control over them. Do you foresee any difficulties? Will you be putting something in your White Paper to cover this point?

(Mr Waldegrave) The pharmaceutical industry, which is one of the great success stories in this country, the Government as a whole has two principal interfaces with it, three I suppose but one not so immediately relevant which is the safety of drugs. The other two are, first, the purchasing of the NHS with PPRS, that is quite important to them, and, secondly, the provision of the science base. When I talk to Glaxo and Smith Kline Beecham what they want to talk about is the provision of good younger scientists and the support of people like students in the Molecular Research Laboratory; they are interested in a science base. I do not feel any sense of conflict with the Department of Health in that matter, their interests are rather different. That very big powerful industry which does a great deal of research inhouse is principally looking to us for what we are basically doing which is good basic research and training of people.

Mr Williams

40. Do you accept the expenditure by Britain on civil R&D is out of line with our European counterparts? I have statistics from economic trends from the Central Statistical Office, August of this year, which shows our own expenditure as 0.51% of GDP for 1990, Germany 0.90, France 0.85 and Italy 0.70% spent on civil R&D. When the Prime Minister has announced now we are going for growth and infrastructure investment is this not an area that cries out for it, it should be a high priority for extra resources?

(Mr Waldegrave) There are two or three different things here. There is the Government's contribution to R&D, to civil R&D, and as far as I remember, and Bill will correct me if I am wrong, we are about in the middle of the pack, are we not, where we have always been traditionally and I think still are, although we have caught up a little bit as in civil R&D done in firms in this country in the 1980s. We have caught up a bit. That is where we contrast badly but if we take the question of outputs: if you take, for example, Japan and Government sponsored R&D, although percentages of GDP is a slippery thing I think we do quite well, the big difference is what goes on in the firms. The response so far of the British Government to that has been to say we should not give, if you like, firms the excuse of not doing their own R&D by getting too near to

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[1] See Appendices to the Minutes of Evidence p. 197.

[2] See Minutes of Evidence p. 19.

[**Mr Williams** *Contd*]

the market so we pulled back in the early 1980s and said we should be doing strategic research and that seemed to work reasonably well. I would need some convincing of that way now to reverse that policy, perhaps that is another question you will come to about frontiers of new markets and so on. We are in the middle of the pack on civil but we still have a long way to go in getting our trading firms to do that R&D.

(Mr Jackson) It is important always while discussing these financial inputs, obviously because they are very measurable people do want to focus on them, it is very important to recognise what is important is outputs from science and these are much more difficult to measure. There are various measures of them and by those measures Britain does very well. That is a point that could be developed. We are intending to publish a study very shortly on international comparisons. When you see that the Committee will realise it is an extremely complicated area, the categories are very slippery and elusive, the reporting from the different countries is of very variable standards. It is difficult to make these comparisons but there is a piece of work forthcoming which will be helpful and will confirm what the Chancellor says, that Britain is in the middle of the pack in terms of inputs but in terms of outputs we do relatively well.

Chairman

41. Some would surely feel that to be the middle of the pack in science and technology spend, however you may wish to explain it in terms of GDP or any other mechanism, at this particular time is not a sufficiently substantial place to be in order to gain the impetus from scientific endeavour in economic recovery?

(Mr Waldegrave) Middle of the pack in terms of financial input. If we are still producing very effective outputs I put us as a very good way above the middle of the pack in terms of output. Some would argue we are still the second or third science nation. I know there are always arguments about the different indices people use, the indices citations and so on, but in terms of outputs we are a good deal better than the middle of the pack. Of course, science above all, even some of the technological programmes we support, are relatively long-term. I would not want to try and push this programme up and down in relation to earlier attempts to push growth. It has got to be a long-term programme.

Mr Williams

42. Do you accept historically we tended to spend rather a lot on defence R&D at the expense of civil R&D? I accept your earlier point about the redeployment of somebody in the defence industry which is not a one on one situation under the civil R&D but judged over a longer period of time. The tendency has been for defence R&D to attract good young scientists and engineers, electronics wizards and what have you, whereas in Japan and Germany and countries that spend rather less on defence they have gone into creating very good consumer goods.

(Mr Waldegrave) There is a good deal of force in what you say. One of the main ideas was it was a national priority within the Coal Board and so on, defence was a national interest and we got a good deal from our scientists, they did what was asked of them superlatively well. One part of the peace dividend might be one will have more of these people in the long-term working on things directed towards investment rather than consumption. After all, defence is a form of consumption; a necessary one but still a form of consumption.

Mr Bray

43. On the point made by the Parliamentary Secretary about filling gaps in the Departmental coverage of R&D Development, the Royal Society in its statement of account on the "Future of the Science Base" recommended that the Chancellor should be given oversight of the expenditure of a "separately identifiable budget to meet *inter alia* activities transcending the responsibilities of individual Departments that nonetheless are, actually or potentially, vital components of the national R&D infrastructure." A possible example of that might be global environmental research where, for example, there is a government-funded Hadley Centre in addition to the work with the Met Office. Do you have plans to establish this new category of expenditure directly under the control of yourself?

(Mr Waldegrave) I do not have plans as of now. That is a powerful argument. I am sorry to keep having to say this a bit but it would be quite a shift in the whole way in which we do things. It would be answering the question we discussed earlier to some extent of shifting the balance between the devolved science distribution organisation and answering that question in one particular way. I do not rule it out; I am considering that.

44. Would you accept that the ear-marking mechanism which you can use in reference to the Research Council expenditure is only of limited usefulness in this respect?

(Mr Waldegrave) If I changed it would clearly be because I came to the conclusion that that mechanism was not enough. I do not yet want—and I am sorry to sound so careful about this—to shut off options fully. There are a number of extremely powerful suggestions in that Royal Society document which I must and will consider extremely carefully and that is one of them.

Chairman

45. Can we turn now to science and industry in a more general sense. Can I ask the Chancellor, the former Chief Scientific Adviser, Sir John Fairclough, has publicly said that the "near-market" policies with which he has been heavily involved have been interpreted by "government ministers and their

[Chairman *Contd*]

officials" in a way which has "driven, even deeper, the wedge between the academic and industrial communities." Do you accept that? If you do, what are we going to do about that?

(Mr Waldegrave) I think anything he says has to be taken very seriously and I have talked to him about this and I have heard what he has to say. I do not believe that that is wholly so in that I do find many industrialists telling me they do find universities very much more responsive than they used to be in the old days and they find working with them easier than it was in the old days. But I certainly do not want to go from one mistake into another. I think we are following some areas far too close to market. If we then get into a rigid ideology of saying, "We don't do anything that appears to be of any use," we would be in an even more absurd position the other way.

46. There is room for reviewing that position though?

(Mr Waldegrave) These frontiers are never going to be exact and clear-cut. We have produced for the European Community our paper on generic technologies, which I think the Committee have a copy of which we do think legitimately should be supported where we are doing work, for example, in material science which we hope is going to provide applications for a pretty swift use by a whole range of companies' products. Indeed, it is that kind of distinction I want to start on. What I want to resist is getting sucked down the path of what is going to be limited funds getting involved in industrial products where you end up with too many eggs in one basket if you are not careful.

(Mr Jackson) Could I just add to that? The idea that government should not get too closely involved in support for near-market science because that was, as it were, industry's responsibility and industry was best-placed to know what was needed and the Government's role was to support things further from the market because that is where the risk of market failure was strongest——we must look at everything afresh but I think that must remain a very powerful doctrine, not least because it is an essentially British doctrine. Some of you will have heard Dr Riesenhuber say that the German government has implemented exactly such a policy in the 1980s and so indeed did the American government as over the last few years governments across the world have been looking at this question and broadly reaching the conclusions that we have been reaching.

(Mr Waldegrave) We agree with that. I think that is a well-rounded doctrine which I would need some persuasion to abandon.

Mr Batiste

47. The problem, of course, is that the relationships and attitudes and culture of societies tend to be rather different. There is this linkage you have been describing between science spend, where you describe us as being the middle of the pack, the science output, which is amongst the best but the third element of that is the industrialists' take-up which in turn produces the money for science spend. I am interested in whether you think, given all the improvements that have undoubtedly taken place over the last decade, whether in terms of scientific take-up for domestic manufacture in the United Kingdom for science spend coming through it to science output, where you would put us in the pack in relation to that now?

(Mr Waldegrave) It varies from industry to industry and it is very difficult to generalise. I have to say that I do not think the situation is good enough and it must be good in this area and I must try to find mechanisms to improve things further. I think there are considerable successes about. There are some industries and some particular universities and research institutions that are doing extremely well in their industrial contacts but I need to be persuaded that we have yet done enough. We have to be the best. We cannot afford not to be the best but in assessing where we put intelligent young people working on generic and strategic research of a kind that is liable to have a plausible sort of application not too far down the road —- Incidentally, and this is a personal view and I hope perhaps you will not attach too much weight to it as it is an heuristic device which I sometimes use to get people to argue against—sometimes it is not the fault of British industry. Sometimes it is that we go off down the road of developing things where there is not actually a plausible industry to take it up at the end and it is no good trying to push into existence an industry that just is not there. You will not get people investing in trying to take on Sony from a standing start. Some of those things in the past I think have led to stories of how wicked British industry is because it will not develop this. If those things exist it is because we have not involved industry earlier enough in the process, it seems to me, of saying where the work should be done.

48. Would you see it as part of your remit to consider the extent to which the most successful take-up in some countries may be related to the tax incentives that might be available?

(Mr Waldegrave) We will certainly have another look at tax incentives. You will certainly know the arguments to and fro. Do you end up supporting those who are a dead weight when they have got to do the research anyway? And so on and so forth.

49. To what extent do you think the ending of the binary line where polytechnics have had a traditionally much closer relationship with market into the university centre flowing from the core is likely to shift the balance of the take of near-market and basic research?

(Mr Waldegrave) I have an idea that the ending of the binary line is not nowadays going to do what it might once have done which is to draw those former polytechnics further away from the market. It may have the opposite effect actually just observing the new figures. Take my own constituency universities,

[**Mr Batiste** *Contd*]

the University of Bristol and the University of the West of England, I think the swift movement of the University of the West of England, the former Bristol Polytechnic, to industry—and do not misunderstand me, University of Bristol, I think you are doing very good work too—they are both now competing to have the right kinds of links with industry in a beneficial way. The fact that ex-polytechnics, some at any rate, are rather more quick-moving in the way they manage their affairs is having a beneficial effect, I think.

(Mr Jackson) Could I just make one point on what Mr Batiste was saying about this very important question about take-up of science into technology in industry. Of course, it is very very hard to show a) relative success in this and b) what the factors are because so many factors are relevant, of which science and technology is only one and perhaps not one of the most important. I suppose if you take the elementary measure, which is the British share of world manufactured trade or trade in manufactured goods, we actually saw some progress in that for the first time in many decades in the late 1980s which I think is a helpful point.

Sir Trevor Skeet

50. Chancellor, you talk about the take-up of industry, but you have got a great number of mechanisms already available to you and we do not see any of these being deleted, for example, ACOST. We have had about 14 reports from ACOST since 1988 to May of this year. It was preceded by a body called ACARD. It has a sister body known as CEST and I think there are some 33 reports from that. Now, with all of these organisations and mechanisms, would it be a good idea to compact them now you have got a Department in order to have good results?

(Mr Waldegrave) I think this is a good moment to take stock, I agree, and there are also quite a range of institutions for technology transfer and programmes for technology transfer. All of them have wholly explicable origins. It is quite a good moment to have, with the help of the DTI, another look at those. I am not saying that I have come to a conclusion, but one should every now and then take Occam's razor, or one of those things, to institutions and see if one cannot simplify them.

51. As you have a Chief Scientific Adviser who will advise you about what ABRC does on the allocation of the science budget, it seems to me that you have got two instruments doing precisely the same thing, and not a great deal left outside them. Might this not be an area in which you can consider it with others? After all, the AFRC are suggesting that there should be one policy-making body and another body doing something else. The MLC have been making recommendations to you for a single body, a national science council. Is this not the time to consider those suggestions?

(Mr Waldegrave) It certainly is. There is a variety of suggestions, happily, from my point of view, nearly all mutually contradictory so that amongst them I can pick out a way forward, I hope, but there are, for example, those who are saying we need a basic science research council and a mission-oriented research council. That is one of the points. Some are saying to go back to Morris and have a single research council. This is the moment to go through these arguments again. The only proviso I would make is that ultimately playing with institutions is the easy part and that it is some of the people issues, the output issues and the measurement of the output issues and the establishment of priorities that is the real core, but if we can find waste in the institutions, for goodness sake, let us save it because we do not want to waste any more than we need to.

(Mr Jackson) Just to add a sentence to that, I detect a slight, to use the Chancellor's felicitous word, heuristic device coming from Members of the Committee, but it is like the interest in centralising. There is a case, which was essentially made by what Mrs Gillan said, for pluralism in this area. We are at the frontiers here of knowledge in the economy and there is not going to be one simple, clear answer. You probably need to have competition to supply answers and ideas so that you ensure that there is a multiplicity of ideas in place. Clearly you do not want to overdo it, it has to be manageable, but there is actually a case for pluralism and diversity at these frontiers in order to ensure that we have the fullest possible range of input into the decisions that have to be made.

Mrs Campbell

52. I am concerned, I suppose, about the gap that I see at the present time between government academia and industry. I think there is a gap and I see that basic science going on at one end of the spectrum and perhaps near-market research at the other and there still seems to me a gap in the middle with bridges that still need to be built to close that gap. I know we have the LINK scheme, but I think the take-up of the LINK scheme is still poor and still not what was anticipated and I think there are many problems. There are problems of academia perhaps not understanding the process of innovation, but there are problems too with industry not knowing what sort of questions to ask academia very often and they do not know what sort of research projects they should be asking academia to do. I wonder if your White Paper, Chancellor, is going to come up with any suggestions for improving bridge-building in that respect.

(Mr Waldegrave) Well, I think it is absolutely crucial and I think this is where a large part of the work in our major agenda is to see if we are in reasonable order in this area. There are some quite good schemes. I think the teaching company scheme is one that works well. I think the LINK, having been very slow, by all accounts, and rather bureaucratic at the beginning, is actually getting better, which is the information I get. There is the suggestion for the Fraunhofer type institute, the Faraday, the Prince of Wales' Award. There are a

[**Mrs Campbell** *Contd*]

variety and then there are some things that exist in particular areas, particular types of area, where for one reason or another people have got together and set up some kind of an institution jointly with industry, with a university, perhaps to read across into others, but yes, this is a crucial area. What I do not want to do (I just want to put down this slight marker) is I do not want to convert universities into research institutes that are wholly working for industry. They must do their job. What industry wants from them is the things that industry cannot do for itself, so it is not so much that we want to change what they do, but it is that they can do it in areas which are more or less useful to industry.

53. Just as a general comment, the areas where this seems to work best are in firms like Rolls Royce who are prepared to spend a great deal of money on pure basic research which does not apparently have any particular applications to what they are doing, but that helps them to build up the links with the universities and helps them to ask the right sort of questions and any encouragement that could be given in that direction would be helpful.

(Mr Waldegrave) I think that is true. There are certain companies, and Rolls Royce is a very good example which I know well from my own constituency which has taken the view over many, many years that they need to be right in amongst the people on the frontiers of metallurgy and other things and they will not actually do that unless they put a bit of money on the table and I think that has paid off very well for them over the years.

(Mr Jackson) And of course this applies to the pharmaceutical companies as well.

Cheryl Gillan

54. In talking to some of my industrial contacts, they have voiced their fears that the OST will concentrate very heavily on core science and leave the technology to the DTI. Do you see this as being a real risk and, if so, is it something which will be in the forefront of your mind in the White Paper because obviously you are going to be sending out conflicting signals to industry, and I was hoping you might have had this type of feedback as well?

(Mr Waldegrave) I have had that feedback very clear and the "T" in our title is extremely important, of the "OST". I said right at the beginning in answer to something you said that I think one of the reasons for the danger, if you like, is that the basic science community does speak in a more co-ordinated voice by its nature, I think, but we are very conscious of this. We are having, I am having personally, and so is Mr Jackson and so are the other people in my Department, regular meetings with industrial companies. We have working with us on the study we are doing in the White Paper the Chief Scientist from the Department of Trade and Industry who is working very closely with us, although I do not for one moment deny there are powerful industries grouped behind other departments, such as Health, as well. It is necessary for us all the time to check that we are not making that mistake.

Dr Bray

55. In your introductory remarks you said, Chancellor, that you had two roles: one in relation to the science budget; and the other in relation to other government R&D. Can we take it from what you have just been saying that in fact you have a third role as well, namely in relation to non-government R&D?

(Mr Waldegrave) I think that is right. I think I did say, and if I did not I should have done, that I regard my office as being the focus, or anyway the public expression of the importance of science and technology in our society.

56. You by no means start from scratch in discussing the role of science and technology in industry and in fact you have had a great deal to say about it yourself and the Parliamentary Secretary was saying just now that there are of course other factors, investment in other things, industry structural questions and all the rest of it. Do you accept that you will be judged on the very substantial dialogue which has already taken place, but within that your contribution has to be to introduce decisions and new ideas and action in this field?

(Mr Waldegrave) Yes, you are absolutely right. I suppose I am just the latest in developments that go back to the foundation of the Royal Institution and beyond, so that this is a battle which has to be renewed every generation, I think. But we have got to find some ways of making measurable progress, yes.

57. Can we take one particular indication of that, accepting that not everything can be done simply by increasing R&D expenditure, still less by simply increasing government R&D contributions to expenditure one way or another. What general influence on the climate in industry do you see it possible to introduce by way of changed competition policy disclosure and ways of realising achievement from an equity base rather than a bank-financed economy and so on?

(Mr Waldegrave) I think there are important issues there. I must slightly guard myself against setting myself targets, must I not? I have no capacity to bring about some of the things you said there. I could possibly influence, for example, exposure and so on. I want to be a little wary of saying, "We won't make progress unless we change the nature of investment in industry as a whole and the long-term borrowing requirements," because I do not quite see how I could do anything about that, at least in the short-term. I think the most important thing would be if we could analyse why those companies that use science and technology in their products are not following the policies of the kind of companies like Rolls Royce and others we were talking about before who seem to be doing it more or less right. Then if

[Dr Bray *Contd*]

we could cross-examine them to see what practically could be done to change their attitudes we might produce an agenda which could produce short or medium-term results.

58. That sort of thing would be and would seen to be Treasury and DTI actions but that does not exclude you surely from being an agent provocateur on these questions in Government?

(Mr Waldegrave) I think that is rather a good phrase and that is rather what I would regard myself as.

Chairman: Chancellor, I am wary that your time is hard-pressed. We had a brief foray on infrastructure and perhaps we will come back to that. We were hoping to get a quick exchange with you on Europe. Perhaps we will leave the "status of scientists" for discussion on a separate occasion with the Chief Scientific Officer, perhaps. Would you care to make a comment to Bill Powell in connection with Europe. Bill?

Mr Powell

59. Can I ask you this: in the past the formulation of policy on European Community scientific activities has been rather detached or appears to have been from the United Kingdom science and technology formulation. The advent of the office of OST provides an opportunity to put that right. Are you intending to put it right?

(Mr Waldegrave) I hope so, yes.

Chairman

60. I think that will do.

(Mr Waldegrave) Can I make one "agent provocateur" remark going back to—and I hope Mr Powell will not be offended by this—just nipping back to what you said you were going to question Bill about, which is the status of scientists. I have a steady stream of industrialists who come and see me and say, "What we need to do is raise the status of engineers and scientists in this country." I say to them, "Excellent, I am glad you have noticed that, Are you therefore gong to pay young engineers and scientists as much as you pay your young lawyers and accountants?" and they say, "Steady on."

Chairman: I take the point.

Mr Strang

61. I have one question that really arises from the publication not so very long ago in relation to the need for nuclear physics when the ABRC report was not published and had an important bearing on the Government's decision. Obviously I would not expect you to comment on that decision but could I put this to you or ask you; would it be your intention to try and adopt a policy that where you received advice based on individuals from the wider community, from scientists and industry, etc as a general rule that advice was published. Of course, we know that ministers have to make decisions and it may not always coincide with that advice but we can at least have a debate or discussion in the most open and informed way on why the Government reached that decision. Would that be a general objective that you would publish all of that information?

(Mr Waldegrave) I think in a way I can say, yes, namely when you have companies coming to you from outside, advice coming to you from outside you should publish it. Where there has been to-ing and fro-ing from the ABRC, where I have published retrospectively advice received for the last two years. It is a sort of hybrid, is it inside or outside technology. David Phillips is an adviser to the Government and is part of the negotiations in the PES round. My predecessors took the view that it actually damaged science if science had to put all the cards down on the table like this and those negotiating elsewhere around Whitehall said, "Oh, that is fine. Now we know what their bottom line is", so it made them bid up and, therefore, it became not real advice and so on. I think the problem was that no one was not quite sure whether that ABRC advice was inside or outside the sort of policy-making tactical core that you need if I am going to have any chance of fighting the corner, as it were. I think, therefore, one of the things that one should consider, and I will consider, is making it clearer what is inside and what is outside so that we do not get into these kind of arguments and when it comes from outside then I think it should be published, yes.

Mr Powell: We all know that from time to time government departments use funds which have been allocated for one purpose for another purpose. I understand the insider's word is "viring" and having been at the Department of the Environment with Mr Heseltine, I can tell you just how a very astute departmental head is able to do that to the public benefit. However, money which is allocated for scientific research purposes may from time to time be hijacked by a government department and used for another purpose and I wondered whether you could let us have a paper which analyses the extent to which this has happened in recent times, but, beyond that, whether you can tell us whether you think you have any responsibility to try and prevent it from happening.

Chairman

62. I do not think, Chancellor, you will be able to answer that, but you might just give a nod of acknowledgement!

(Mr Waldegrave) There are some quite big issues involved there. I do not want it to be thought, and I am sure Mr Powell does not, that there are public accounting issues here. I am sure everything has been done with proper propriety. The issue is really whether Bill has written firmly on his piece of paper, "Not more papers please", but I will discuss with Professor Stewart whether there is a meaningful way of answering this question. I know what you are getting at which is, "Last year he advised on how

[**Chairman** *Contd*]

much should broadly be spent on science and a certain figure was come to and was that figure actually spent on science?" is what you are asking.

63. Anything that you could do to assist that with papers from Bill Stewart or indeed a comment he might make when he comes back.

(Mr Waldegrave) It is a real point and I quite understand why it was asked.

Dr Bray: No doubt the Chancellor knows the SERC published today their programme for the next three years which is a new departure.

Chairman: Chancellor, thank you for your presence and that of your Parliamentary Secretary and your Chief Scientific Adviser. We are most grateful and we will continue to probe our other visitors to this Committee, but this is the first session and the first occasion we have had the Chancellor giving evidence and we are very grateful with the way in which you have provided us with information.

TUESDAY 3 NOVEMBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Cheryl Gillan
Mr William Powell
Sir Trevor Skeet
Dr Gavin Strang
Mr Alan W Williams

Memorandum submitted by the Department of Trade and Industry (9 October 1992)

EXECUTIVE SUMMARY

This memorandum outlines the range of DTI R&D schemes. It describes the wide-ranging networks of contacts that DTI has with other Government Departments and the Research Councils which, associated with appropriate co-ordination by the Office of Science and Technology (OST), result in a broad consensus about R&D policy and priorities. This applies from the broadest levels, where OST is most involved, to the level of detailed programmes and projects where direct bilateral or multilateral links predominate. The memorandum also outlines DTI's internal activities to assess priorities, in the framework of this broader consensus.

MEMORANDUM

1. This memorandum describes those activities of the Department of Trade and Industry (DTI) which are concerned with research and development (R&D), in particular, how DTI co-ordinates its R&D activities with those of other Government Departments (OGDs) and how research priorities are established.

2. In January 1988, the DTI published a White Paper "DTI—the department for Enterprise" (Cm 278), which set out the Department's main policies for encouraging enterprise. On innovation, new policies were announced which involved a move away from near market R&D support, following the conclusions of an earlier internal review of DTI's role in encouraging innovation, and which now forms the basis of current DTI R&D policy. The general aspects of this policy are currently being reviewed in preparation for the forthcoming White Paper on Science and Technology (S&T).

RESEARCH AND DEVELOPMENT PROGRAMMES

3. Since the 1988 White Paper, DTI's R&D policy has focused on circumstances where the risks to industry are greatest or where the benefits of the research would be widespread. Programmes have therefore concentrated on pre-competitive, collaborative R&D, on technology transfer and on support for smaller firms. In addition, support is given to specific technological areas which have benefit to the whole economy. One of these is energy R&D which is now DTI's responsibility following the recent merger of the Department of Energy (DEn).

Collaborative Research

4. DTI has four collaborative schemes offering up to 50 per cent support for pre-competitive research where the technological risks are high:

4.1 *LINK* is a Government-wide initiative which encourages industry to undertake collaborative research jointly with science-base institutions (e.g., Higher Education Institutions (HEIs) and Research and Technology Organisations (RTOs)). The research is pre-competitive but industrially relevant. Across Government there are now 30 LINK programmes (£194 million total Government funding). DTI is the major player, involved in 27 programmes (106 million DTI funding), with the Science and Engineering Research Council (SERC) being involved in 25 programmes. Current areas supported include: food and biosciences; advanced materials and chemicals; advanced manufacturing and engineering; electronics and communications; measurement and sensing.

4.2 *EUREKA* is a pan-European initiative (membership comprises the twelve European Community countries, six European Free Trade Association (EFTA) countries, Turkey, Hungary, and the European Commission) with the aim of facilitating collaborative research and development projects between companies, RTOs and HEIs in different European countries. Over 600 EUREKA projects have so far been approved involving an estimated total investment of £6 billion. DTI may fund UK participants in EUREKA projects and, to date, has committed some £90 million to 110 EUREKA projects.

4.3 *Advanced technology programmes (ATPs)* support pre-competitive collaborative research in new technologies. The aim is to build up UK capabilites in key technologies and accelerate their application, thus improving the competitiveness of British industry. There are currently 15 programmes in areas such as advanced information technology, manufacturing technology, tracked transport, advanced robotics and undersea technology. To date, DTI has allocated some £190 million to its advanced technology programmes.

4.4 *Club R&D* projects support pre-competitive, collaborative research in any industrial sector. Projects are usually based at RTOs, who act as the host organisation, and are a particularly effective way of encouraging collaboration between companies, especially small and medium-sized enterprises (SMEs). They encourage the widespread diffusion of knowledge and skills through the RTO's membership, which are mostly SMEs. Support for other collaborative projects not covered by the schemes above is also available.

Technology Transfer

5. DTI's support for technology transfer is aimed primarily at SMEs and covers not just new technology but also the transfer into commercial applications of best practice techniques and technology. DTI's spend for 1991-92 is estimated at £93 million on programmes covering specific technology areas, technology based consultancies and education and training initiatives. The following examples illustrate the range of schemes employed.

5.1 *Managing into the 90s* was launched in 1989 to stimulate the spread of best practice, including the effective use of new methods and technology among chief executives and senior managers, primarily in SMEs. The programme emphasises the need to adopt an integrated approach to the management of design, quality, manufacturing and purchasing. Activities involve seminars/workshops, visits to demonstration companies and a strategy roadshow. In the third year of the programme over 13,000 people attended events throughout the country.

5.2 *IT Technology Transfer programmes.* The Advanced IT Technology Transfer programme raises awareness of recent IT advances amongst senior industrial and commercial managers. The Vision Technology Transfer Centre, run for DTI at the National Engineering Laboratory, promotes awareness and take-up of vision technology by industry, particularly by small and medium-sized manufacturing firms. The Advanced Control Technology Transfer programme provides information to companies to enable them to assess potential improvements in competitiveness through adopting Advanced Control. The Neural Computing Technology Transfer programme promotes increased awareness and use of neural computing and will improve business knowledge of the technology.

5.3 The *Teaching Company Scheme* (TCS) aims to change traditional attitudes and to form lasting partnerships between higher education and industry in order to improve UK industrial performance, and management. The scheme is sponsored by DTI, SERC, the Economic and Social Research Council (ESRC), the Ministry of Agriculture, Fisheries and Food (MAFF), the Department of the Environment (DoE) and the Department of Economic Development in Northern Ireland. Under the TCS, young graduates working in a company under the joint supervision of company and academic staff, tackle tasks associated with the introduction of new technology and methods, and at the same time develop their own technological and managerial skills in an industrial setting. The TCS concept is being extended by the addition of a new programme, the Senior Academics in Industry Scheme (SAIS), solely funded by DTI, which aims to give senior academics up-to-date industrial experience by allowing them to undertake new technology projects in companies themselves.

5.4 The transfer of *technology from overseas* is encouraged through, for example, assistance for overseas missions by technologists who then report back on overseas technology developments; facilitating access by UK industry to technical information collected by overseas Embassies; and, assistance for engineering managers to learn about Japanese technology by working in a Japanese company.

5.5 Other technology transfer schemes cover areas such as promoting the spread of best environmental practice among companies, promoting the use of new and improved materials and encouraging HEIs to "audit" the commercial value of their research and technology.

Smaller Firms

6. Smaller firms play an important role in innovation but have greater difficulty financing high risk projects. Single company support is therefore available to them through the two schemes below. SMEs are also encouraged to take part in the collaborative and technology transfer schemes mentioned above; in LINK, for example, SMEs appear in 40 per cent of projects.

6.1 *SMART (Small Firms Merit Award for Research and Technology)* is an annual competition which offers grants to stimulate innovative technological projects in businesses with fewer than 50 employees. By the end of 1991 almost 700 projects had been supported by the scheme. A further three year programme of SMART competitions, worth £40 million, was announced early in 1992.

6.2 *SPUR (Support for Products Under Research)* helps smaller firms be more innovative by providing grants towards the cost of new product and process development projects which demonstrate a significant technological advance. Single companies with up to 500 employees may be eligible for a fixed grant of 30 per cent of the DTI eligible project costs, up to a maximum grant of £150,000. To date, over 180 grants had been offered, worth over £17 million in DTI support.

Specific technology areas

7. In addition to encouraging industrial R&D, the Department supports a wide range of R&D programmes to fulfil its policy and statutory obligations and to support technologies important to the whole UK economy but which would not otherwise be undertaken. This includes support for nuclear and non-nuclear energy R&D, aeronautics and aeroengines, space technology, and statutory, regulatory and policy work through DTI's research establishments, including measurement and standards.

7.1 *Nuclear energy R&D*. As a result of the merger with the Department of Energy, the DTI has inherited policy responsibility for civil nuclear power. The Department funds a programme of nuclear research, with the work currently being commissioned mainly from the United Kingdom Atomic Energy Authority (AEA). Programmes are concerned with safety and health; safeguards and non-proliferation issues; radioactive waste management and decommissioning liabilities; support for the European fusion programme in investigating the scientific feasibility of fusion as a source of electricity in the long term; and, with the development of the fast reactor at economic cost. The Department's expenditure on nuclear R&D is reducing (estimated at £93 million in 1991-92 and at £84 million for 1992-93) and will decline significantly further when the Prototype Fast Reactor at Dounreay closes in March 1994.

7.2 *Non-nuclear energy R&D* programmes essentially support work which would not otherwise be undertaken on an appropriate timescale or to an extent commensurate with current and future UK needs. However, they also encourage UK industry and commerce to develop capabilities, services and technologies related to the efficient supply, distribution, and use of energy, and ensure the effective dissemination of the results of R&D work.

7.3 The Department's estimated spend on non-nuclear energy R&D for 1991-92 is £37 million. This includes developing advanced offshore technological capability through the Department's Offshore Supplies Office (OSO), improving the environmental acceptability of coal utilisation, and a large suite of programmes to encourage the development and application of renewable energy sources. Work in this area covers energy sources such as solar power, biofuels and wind, tidal, wave and geothermal energy.

7.4 *Aeronautics and Aeroengines*. DTI spent about £17 million in 1991-92 supporting the UK's aerospace technology base, through the Civil Aircraft Research and Demonstration (CARAD) programme. This supports research and development work at the Defence Research Agency (DRA), RTOs, HEIs and industry. Environmental issues are of particular concern, especially with the likely increase in exhaust emissions. CARAD funding will assist UK industry in developing engines with lower nitrogen oxides emissions. Other work supported under CARAD includes Computational Fluid Dynamics (airframes), aircraft and cockpit systems, propulsion systems and next generation Super-sonic passenger aircraft.

7.5 *Launch aid* is provided under the Civil Aviation Act 1982 for specific projects in the aerospace industry, such as the EH101 Anglo/Italian multi-role helicopter on which Westland are collaborating with Agusta and the Airbus A330 and A340 on which BAe is collaborating with its partners in the European Airbus Industrie consortium.

7.6 *Space technology*. DTI's R&D activities in the space field form part of the Government's overall civil space programme which is integrated through and managed by the British National Space Centre (BNSC). BNSC is a partnership of eight Government Departments and Research Councils—DTI, DoE, Foreign Office, Ministry of Defence (MoD), Cabinet Office (represented by the OST), Meteorological Office, SERC and the Natural Environment Research Council (NERC). Approximately two-thirds of BNSC's programme expenditure is on European collaboration through the European Space Agency (ESA), and one-third on national programmes designed mainly to complement ESA programmes and develop the UK's technical capability to exploit opportunities in ESA. BNSC's funding comes from the budgets of a number of its partners: the DTI is the major contributor, providing some £95 million in 1991-92 out of an annual total of about £160 million.

7.7 Currently BNSC aims, through ESA and national programmes, to develop the potential of satellite Earth observation data as a commercial opportunity and as a means of satisfying public policy and scientific needs in the environmental area; to develop and demonstrate specialised telecommunications technologies distant from the market; and to maintain a sound space science base.

7.8 *Statutory, Regulatory and Policy support*. DTI commissions R&D necessary to fulfil its policy responsibilities towards industry, in areas such as the National Measurement System, consumer safety, geological surveys and environmental issues. Work is carried out by DTI's Research Establishments (REs), other Government REs or private sector research bodies, depending on who offers best value for money. This follows as true customer-contractor relationship developed since April 1990. Warren Spring Laboratory (WSL), the Laboratory of the Government Chemist (LGC), the National Physical Laboratory (NPL) and the National Engineering Laboratory (NEL) are all now executive agencies exempt from gross running costs control.

7.9 The research and technological support required by DTI for its statutory, regulatory and policy objectives, is largely funded through the *Measurement and Technology Support* (MTS) budget. Gross expenditure in 1991-92 is approximately £62 million, but is expected to increase to some £74 million in 1992-93 with the transfer into it of the funding for DTI-supported research at the NEL. The Department also maintains a research programme in propagation and radio technology (£3 million in 1991-92) in support of its management of the radio frequency spectrum: this is fully funded by income from Wireless Telegraphy Act licensees and other users.

Co-ordination with other Government Departments

8. The programmes described above give an idea of the range of research and development work supported by DTI. Inevitably there is a common interest in some of these areas from other Government Departments, such as Environment, Transport, Defence and the Research Councils. DTI therefore ensures that there are good communication links between it and other Departments so that others' interests are taken into account in the consideration of both overall policy areas and priority setting and also in the support of individual projects and programmes.

9. The primary method of interdepartmental co-ordination on R&D activities is through interdepartmental committees operative at Ministerial and official levels, chaired and serviced by the Office of Science and Technology (OST). DTI also has many bilateral and multilateral links with other Government Departments (OGDs) outside the OST network. Advisory committees and interdepartmental steering groups at appropriate levels continue this co-ordination through various stages of both policy and programme setting.

10. The President of the Board of Trade is a member of the Ministerial committee on science and technology which discusses the whole range of S&T across Government. Objectives and priorities discussed and agreed there form the basis for work in the appropriate Department. Discussions also take place at the corrresponding committee of officials, chaired by the Chief Scientific Adviser, OST, where DTI's Chief Adviser on Science and Technology (CAST) meets regularly with other Departmental Chief Scientists.

11. DTI's Chief Adviser on S&T is also a member of a number of other interdepartmental advisory committees and groups which look at specific technology or programme areas. For example, on science base related issues he is a member of the Science and Engineering Research Council (SERC) which takes an overall view of the work supported by SERC through its individual Committees. On defence issues, he is a member of the Defence Scientific Advisory Council (DSAC) which advises the Ministry of Defence on priorities for defence R&D. He also sits as an assessor on the Advisory Council on Science and Technology (ACOST) which advises the Prime Minister on S&T issues across Government.

12. In parallel to DTI's Chief Adviser's input, other senior officials are represented on other advisory committees. For example, in the space field, BNSC operates a system of consultation both within Government and externally. BNSC's Resources Board has representation from each of BNSC's Government Partners, including the OST, and maintains overall direction and co-ordination. The BNSC Director General has his own advisory panel of industrialists. And in each major area of activity—Earth observation, science, technology and telecommunications—BNSC has programme boards composed, as appropriate, of representatives of Government, industry (both as producers and users) and academia. A Space Assessment Committee, chaired by the Director General, supervises the administration of the DTI space budget. Decisions on UK participation in all major ESA programmes are taken by Ministers in the light of advice from BNSC.

13. In addition to the above high-level groups, DTI officials at the working-level sit on a number of R&D liaison and steering groups set up to advise on specific DTI programmes. Other Departments with a common interest are represented at such groups and likewise, DTI officials are represented on other Departments' steering groups. In the environmental field, for example, DTI officials sit on DoE's Global Atmosphere Research Requirements Group, the Air Quality Research Requirements Group and the Interdepartmental Group on Cleaner Technology.

14. In the aerospace field, research activities covered by CARAD are discussed at DTI's Aviation Committee which is attended by representatives of other departments with an interest. There is a continuing dialogue with the Defence Research Agency (DRA) about CARAD supported work, both at a strategic level and in relation to details of implementation. There is also joint funding with other Government Departments, for example the Civil Aviation Authority (CAA) and the DTp on explosion hazards research, and MoD/DRA on that and other projects.

15. Joint funding of schemes is another mechanism by which DTI co-ordinates its R&D activities with OGDs. LINK, for example, is a cross-government R&D support mechanism, which is sponsored by all of the major departments supporting R&D (DTI, MoD, DoE, MAFF, Department of Health (DH), Department of Transport (DTp) and Scottish Office Agriculture and Fisheries Department) and the Research Councils (SERC, Agriculture and Fisheries Research Council (AFRC), Medical Research Council (MRC) and NERC). DTI is the leading sponsor of LINK programmes and, as such, is represented at the LINK Steering Group by its Chief Adviser on S&T. At this strategic level, co-ordination with other Departments and Research Councils is strong and is supported by the LINK Secretariat (housed within DTI) which maintains close working contact with officials across the range of sponsors. At the workface, each LINK programme has a joint secretariat, again drawn from the various sponsors, and representation from funding organisations on its management committee. In this way, within the confines of its supported topics, LINK offers a process for comunicating and co-ordinating research between departments having common research interests.

16. Another jointly funded scheme is the Environmental Technology Innovation Scheme (ETIS) which is jointly run and funded by DTI and DoE and aims to encourage environmental innovation and improved environmental standards in the UK. The split of funding reflects DTI's and DoE's complementary interests in environmental activities. Other departments may also be consulted depending on the nature of specific projects, e.g., MAFF on agricultural waste, and DTp on vehicles emissions.

17. There is also a continuing dialogue between individual officials of DTI with other Government Departments through personal contact and by consultation on policy papers and programme plans.

Research priorities and the effect of the Office of Science and Technology (OST)

18. Earlier this year, a new Office of Science and Technology was created within the Cabinet Office, bringing responsibility for science and technology issues under the Chancellor of the Duchy of Lancaster, acting for the Prime Minister. The establishment of a Science Minister in Whitehall provides an opportunity to shape science and technology policy in the United Kingdom for years to come.. It also ensures that for the first time in many years, we have a Minister who can meet on an equal footing with other European and international representatives of S&T in their countries.

19. The OST provides a strong central focus for the development of Government policy on science and technology. In conjunction with other Government departments, in particular the DTI, the OST will discuss ideas on the exploitation of science and the application of technology. Government's aim is to help achieve the maximum contribution to our quality of life and wealth creation from Government expenditure on S&T. DTI, with its wider responsibility for industrial innovation, will be working closely with the OST on a number of issues, in particular, developing a more industry-orientated R&D policy. This approach will help ensure that more innovations are effectively translated into the market place thereby enhancing competitiveness and increasing wealth creation.

20. DTI will be working closely with the OST in the preparation of a White Paper on science and technology to be published in 1993. The White Paper will look at arrangements for funding and managing S&T and consider whether they help the country get maximum value from the resources provided. To help inform the DTI's input to the White Paper, the Department's Innnovation Unit is consulting widely with industry to obtain their views. The Units's industrial secondees help ensure that it is well placed to carry out this consultation.

21. The formulation of new policies and establishing priorities for S&T expenditure, is greatly aided by the extensive network of liaison between DTI and OGDs, including the OST. Involvement in the interdepartmental committees gives DTI an informed view of overall Government priorities, and this, together with wider consultation with industry, academia, trade associations and other organisations, enables priorities to be set in line with the needs of the UK as a whole.

22. To complement internal and interdepartmental consultation, DTI takes advice from a number of outside sources. Advice on the direction and quality of DTI supported programmes is taken from the advisory committees mentioned above, many of which include not only DTI and other Government officials, but also senior representatives from industry, academia and intermediary organisations.

23. In establishing policy objectives, the Department takes account of recommendations of Parliamentary Select Committees. In addition, DTI takes advice from independent bodies such as the

Confederation of British Industry (CBI), ACOST, and others, such as the Innovation Advisory Board (IAB). Both ACOST and the IAB include as their members, senior industrialists, academics and engineers, who provide an informed view on S&T priorities.

24. Priority setting for the innovation-related budgets of DTI is conducted through Department-wide Five Year Forward Look (5YFL) surveys which include the main budgets for civil industrial R&D—the Innovation budget and the CARAD budget. Following extensive consultation, spending divisions identify broad topics under which they believe R&D projects should be offered support over the five-year period, with options for growth or decline in expenditure.

25. These divisional views are tabled at a priority setting forum chaired by DTI's Chief Adviser on S&T and attended by senior independent advisers as well as senior officials. Having assessed the merits of the different plans, the forum advises on the relative priorities of each and the outcome of the exercise contributes to the later allocations from the Innovation budget to individual areas of activity.

26. LINK is an example of an interdepartmental scheme which, whilst within the Innovation Budget and therefore subject to five year plans, also has an integral system of priority setting by virtue of its wide membership. The seven Government Departments and four Research Councils participating in LINK, are closely involved with establishing and approving any new LINK programme in which they are involved. During the subsequent operation of the programme, steering of the research undertaken and approval of individual projects, is typically undertaken by a management committee on which the needs of both participants and sponsors are represented. In this way, LINK reflects priorities across Government Departments and the research needs targeted by industrial and academic participants. So far as OST is concerned, both their Chief Scientific Adviser, and the head of the Advisory Board of the Research Councils (ABRC) are members of the LINK Steering Group, which offers strategic direction and monitoring on the initiative as a whole.

27. The Joint Framework for Information Technology (JFIT) is the mechanism which brings together DTI and SERC to co-ordinate and prioritise their activities in IT. Through JFIT, DTI and SERC support IT research, technology transfer, education and training, and standards work, throughout the UK, taking into account European and international initiatives. In setting priorities for these activities, DTI and SERC receive advice from the Information Technology Advisory Board (ITAB), which brings together senior members of industry and academia, and other Government departments, and provides strategic advice to DTI and SERC across the whole spectrum of Government support for IT.

28. Priority setting within other budgets takes on a slightly different format according to the needs and structure of the specific technology area. Within the nuclear R&D programme, for example, priorities are set according to the Department's nuclear policy objectives. In this, the Department is advised by the Advisory Council on Research and Development (ACORD) who consider annually the priorities for nuclear R&D, assisted by the Atomic Energy Technical Unit, comprising experienced nuclear scientists and engineers, who are responsible for project management and technical advice. ACORD also advises the Department on R&D priorities for non-nuclear energy and also environment.

Referral to the Research Councils

29. As regards individual project applications, the DTI considers a part of the normal appraisal process, whether particular applications would be better directed to the Research Councils, and takes action as appropriate in such cases.

30. All DTI programmes which have some relation to science base work, have on their programme committees or steering groups, members of relevant Research Councils, particularly SERC and, through resultant consultation, therefore ensures that it does not take on projects more suited to the Research Councils. Conversely, DTI officials, including the Chief Adviser on S&T, attend a number of Research Council committees as assessors.

31. In assessing proposals for support under the Innovation Budget, DTI regularly considers the most appropriate mechanisms and avenues for support. Where HEIs feature prominently in a proposed programme of research, LINK may well be the most appropriate mechanism. The LINK scheme draws together OGDs and Research Councils to jointly fund areas which are not exclusively of interest to one Department or public sector R&D funding body (such as Research Councils). DTI attaches high priority to proposals which draw on the existing science-base to the benefit of UK industry and which involve the active participation of industrial companies. Projects involving predominantly academic researchers would be unlikely to be eligible for DTI support.

Examination of Witnesses

RT HON. MICHAEL HESELTINE, a Member of the House, President of the Board of Trade, MR EDWARD LEIGH, a Member of the House, Minister for Technology, DR GEOFFREY ROBINSON, Chief Adviser on Science and Technology, and DR COLIN HICKS, Head of Research and Technology Policy Division, Department of Trade and Industry, were examined.

Chairman

64. President, you are very welcome here to give evidence before this Committee, which, as you know, is conducting a survey, an inquiry, into the newly appointed Office of Science and Technology, and you are very welcome with your colleague, the Under Secretary, Edward Leigh. We are glad to see you and your officials here, whom no doubt you will introduce to us at the appropriate time. Would you wish to commence by offering any statement or general point you would like to make before we move to questioning or would you wish us to move to questioning straightaway?

(Mr Heseltine) I would like to thank you for your generous words of welcome to myself and to Edward Leigh, who is the Minister for Technology in the Department of Trade and Industry. Perhaps I could begin by introducing Dr Geoffrey Robinson, who is my Chief Adviser on Science and Technology and who joined the Department just a little after I did from IBM. On my far right is Dr Colin Hicks, who is the Head of the Research and Technology Policy Division in the Department of Trade and Industry. I would not wish to detain the Committee for more than a moment in thanking you for inviting us to come here and to say how much we welcome the opportunity to discuss our contribution within the DTI to the newly enhanced role of science and technology within government. I know that you have seen the Chancellor of the Duchy, who, of course, is in overall responsibility now for science and technology policy. I would hope to answer your questions about the way in which we work together and the way in which we wish to play a constructive role in the policy that he is formulating. The policy itself will, of course, be included in a White Paper next year, which is now the next focal point of this discussion.

65. Thank you, President. If I may open the questioning by relating to what you have just said, obviously one of the things that is of interest to this Committee is the overview which we understand from the Chancellor of the Duchy the OST will now have in relation to the major departments which have scientific and technological responsibilities, of which yours is indeed one. Would you care to comment on what, in your view, you would see as the benefits of this new policy of overview by the OST and what perhaps are the disadvantages, if any, which you see in it?

(Mr Heseltine) I am a strong supporter of the concept of a government approach to science and technology. Obviously, viewed from the Department of Trade and Industry the interests that we have are to maximise the benefits to the trading economy from the scarce scientific resources that are inevitably available. There will be, of course, other government priorities which other ministers will feed into the White Paper process which is under way. Very much our priorities are to see the maximisation of those resources in the wealth-creating process.

Dr Bray

66. For a company, would you regard research and development or technological development as an inherent part of the corporate strategy which you really cannot separate from financial market considerations?

(Mr Heseltine) For a company?

67. For a company?

(Mr Heseltine) It will obviously vary a great deal depending on the nature or trade of the business in which the company is involved, but I would expect any company to ask itself questions about whether it needs to pursue policies of that sort in the furtherance of its corporate objectives. There are obviously many industries, many companies, where a high commitment to research and development and science and technology are absolutely unavoidable for success; there are other industries where they are much less important.

68. Clearly the position does vary a great deal from one industry to another but do you feel that, looking at the picture as a whole, there are bridges that need to be strengthened between manufacturing, on the one hand, and the financial sector, on the other?

(Mr Heseltine) I think it is a very important issue and a very big issue and it strikes at the core of one of the debates that continues about the relationship between the owners, managers, of the nation's savings and the managers of the wealth-creating companies. There are many ways of looking at this issue and my own conclusion now is that the most important contribution towards an understanding by the financial organisations that tend to invest in and to own companies and those companies themselves is the creation of an economic background of growth and predictability. That tends to bring together the self-interests of the two different aspects of the capitalist system. If one is involved in a climate where the economy is starting and stopping, if one is in a situation where there is high inflation, where there are high interest rates, then those people who are responsible for investing money tend to have a short-term or opportunist view. They find more attractive ways of investing their money and making their profits than they do in backing the longer-term returns of manufacturing industry. If you get consistent low inflation growth policies, usually associated with low interest rates, you are much more likely to create that sense of common purpose between the two sides of the capitalist system. I do not know whether that is quite what you had in mind in asking the question.

[**Dr Bray** *Contd*]

69. Indeed. Pursuing that particular line of thought, do you think there are bridges that could be strengthened between the wealth-producing sector or manufacturing, which I always regard as narrower than the wealth-producing sector, and the management of the economy? The management of the economy does not always appreciate the particular conditions required for manufacturing.

(Mr Heseltine) I think one of the changes that I want to build into the Department of Trade and Industry is precisely to strengthen that sort of argument in the decision-making processes as a whole. I think it is very important and I think it is interesting to note how generally the public debate has widened to recognise the significance of the wealth-creating process and of the relationship between those who manage it and the public sector that surrounds it.

70. In seeking to strengthen the recognition, has the OST a particular role to play which is supportive of the case you are arguing?

(Mr Heseltine) I think that the whole of government has a role to play and it is much wider than the OST, but the OST certainly has a role to play because it is at the interface between the public and private sectors, whether it is in the field of pure research, the research councils, whether it is in the management world, the universities, or whether it is in the relationship it has with the various departments, who are often in the grant-distributing relationship of public money in the private sector. So the OST is at the centre of a very wide-ranging, broad and complex relationship between the private and the public sectors and, therefore, must be important in influencing the links to which you drew our attention.

71. Specifically the OST is responsible for the Economic and Social Research Council. Equally, it finances the greater part of the research on which the Treasury depends. Do you not need an inside track of the ideas before they get to the Treasury?

(Mr Heseltine) I have always worked on the assumption that the Treasury is all-knowing, all-seeing.

72. Is that a safe assumption?

(Mr Heseltine) It is the only assumption that is safe if you are spending money.

Sir Trevor Skeet

73. But surely, President, the principal problem we face today is the perspective of British industry, which is short-termism, which is entirely different from that in Germany, Japan and France. How are you going to make them look forward five to ten years rather than over a short period in which they may not be interested in technology and science?

(Mr Heseltine) I think if one looks at the make-up of British industry, as one would expect it represents many different companies in many different industries. It embraces companies which have perhaps not enjoyed the happiest of fortunes. It embraces world-class companies that are the best that can be found. So I do not think there is a generalisation, except that we have seen too significant an erosion of the manufacturing base over at least the 40 years of the post-war world and arguably longer. If you talk then about the change in the climate from the short-term to a longer-term perspective, I think there are many ways you do that, but I would put at the top of the list the economic management of the economy. It is the vagaries and the unpredictabilities, the stops and starts, that I think have broken that sense of confidence and that attitude of long-term policy-making that has been characteristic of some of the more successful capitalist economies. I have not any doubt at all that when you have seen periods of consistent growth and significant profits, that has led to a more confident attitude towards investment, understandably, in British industry which tends to have come to an end at a time when, for economic reasons, the economy has slowed down and broken the confidence factor.

74. On the other hand, the pharmaceutical companies invest extremely heavily in research and development, whereas other companies only spend a very small percentage on it. They are thinking about their shareholders at the next meeting.

(Mr Heseltine) I think the pharmaceutical industry is in a special relationship with government. They supply an important part, but not, of course, in any way the whole part, of their product to government and the conditions under which they operate are very tightly regulated by government. The quality control is absolute. So there would be no way in which the pharmaceutical industry in this country—and I would guess it is the same elsewhere—could do other than maintain levels of research in order to satisfy the marketplace, which is in broad terms the health service in this country, about the quality of its product.

Chairman

75. We have heard criticism that there is a lack of understanding of the process of innovation in government and academia. Do you agree with that?

(Mr Heseltine) No, I think I am a sceptic about generalisations. There will be competing pressures. If you are looking for the allocation of resources in Whitehall you will find all sorts of arguments from different ministers and different government departments, all with their own legitimacy, as to where the money should be spent. If insufficient money is perceived to have gone into the field of what could broadly be called long-term wealth-creating investment, the pressure groups, the interest groups, in that field will say the money has been unwisely spent for this or that reason, but that is the only allowance in terms of political priority-making and decision-taking. I think the world in which I see it would recognise that there is some truth, but not the whole truth, in that suggestion.

Mr Powell

76. Mr Heseltine, in 1990/91 the two departments for which you now have responsibility, Trade and Industry and Energy, were responsible for approximately 45 per cent. of the civil department expenditure on research and development and, therefore, you are responsible for by far and away the lion's share of what has gone into research and development from government sources in the recent past. To what extent was it a criterion or a major criterion of the selection of such projects that it was designed to underpin and improve company profitability?

(Mr Heseltine) I think one would have to go back over the different grants and the different regimes and I think it is self-evident that you are asking me about the policy that was formulated and administered long before I was in the Department. We have all sorts of objectives and in a sense they can be associated with profits for the companies, although they are not formulated with a view to the profitability, but I can produce examples. We have support programmes for the aerospace industry. It has been decided by government policy for longer than I can remember that this is an industry where the nature of the international arrangements is such that government support plays a role either through the civil support programmes or through the defence programmes, and it is very difficult to see a free-standing industry that is viable without such relationships. It is not about bolstering the profits of particular companies; it is about maintaining the strategic capabilities of certain advanced technology industries. I think the same arguments apply to the support that has been given to Rolls-Royce in certain circumstances in the space industry. It is not about the profits of the company; it is about the technological success of certain key industries. I could give you another example of the same thing, where we have programmes designed to help small businesses. They are not programmes there to make those companies profitable. They are there to help small businesses to maintain a presence in technologically advanced fields. So I think it is inevitable that there is a profit link and profit benefit and pay-off perhaps from what we do but it is not to make them profitable. It is not a profit-seeking programme; it is a science and technology programme.

77. You have alluded to the way changes you have made impact on the way your Department's budget is distributed. Will enhanced company profitability form any part of the new criteria you might wish to lay down in the selection of government backing?

(Mr Heseltine) In terms of the use of the science budget, I do not think we will start by seeing how we will make this company more profitable in terms of using the science budget. We might ask that question in general policy-making, in dialogue with the Chancellor or whatever it may be, but in terms of the science budget I think one of the early conversations I had with Dr Robinson here arose, as a matter of fact, out of our consideration of the Faraday proposals, which we have become responsible for and which we have looked at, and we are continuing to look, in the process of the White Paper review, at the range of different grants that my Department administers to see whether we want so many different sorts of grants, whether they are in the right area, whether the disciplines are right. We are conducting a very fundamental review about the precise allocation of the funds within the Department but that is to see whether we think the science policy, the technology policy, is right, as opposed to whether we are actually getting profits into the companies concerned.

Mr Batiste

78. Moving on a little from that and looking at this general question of the information that is available so as to make judgments, it has been suggested to us in evidence that high-tech companies, particularly in the small- or medium-sized sector, tend to have a lower failure rate than companies in other sectors. I remember other reports before in evidence to this Committee saying similar things, and I remember also them saying that high-tech companies in the south of the country tend to have a higher success rate than in the north. The problem is that there is not very much in the way of statistics available to make any immediate judgments about that. Has your department done an analysis of this or does it plan to do so?

(Mr Heseltine) I am, as I said, a sceptic about generalisations of this sort, but if none of my colleagues has the answer we will search our records to see if we have such statistics.

79. I suspect the answer may be that there are a lot of factors which go into it?

(Mr Leigh) I can mention the SMART scheme, which is a scheme to help innovation in small companies, and the interesting thing that I learnt about it, when visiting the East Midlands region recently, is that of all the SMART awards given in that region—and there have been a considerable number since the scheme started—only one of those companies, those small high-tech businesses, has actually gone into liquidation. So I think that actually reinforces the point you make, that these high-tech companies tend to be more successful than the low-tech companies. That is why we have placed a high emphasis on SMART in the past because it has been very successful.

80. The Committee would be very interested if there is any evidence in the Department in knowing what it is because there is a lot of academic interest in the subject as well and it would be of help to this Committee in developing it. Can I take it a stage further because I understand the Department is looking around the world for models that might be adapted to the United Kingdom. Obviously we have taken up science parks in the United Kingdom, where the United States led the way. What would

[**Mr Batiste** *Contd*]

you define as a science park in a meaningful sense? Some of them are attached to industrial sites, others have close links with universities. We would like to probe a bit about how you see the role of the science parks, whether you see them as successful in supporting science or whether you see them as a fancy way of doing industrial development?

(Mr Heseltine) You can have what you might describe as a romantic view of a science park, which is a lot of talented, skilful, highly qualified industrialists and scientists pioneering in the state of the art, relatively small businesses which grow into world beaters, making a huge fortune in the process, usually surrounding a university campus. That would be a quick guide to the science park. If I were a property developer and trying to attract people into my rather expensive looking buildings which happened to be located in a fairly attractive site or along a motorway, I might well be persuaded by my marketing director that if I could give this particular development a flavour of science, high technology, that would attract rather more people than if I gave the impression that it was a low-grade warehousing operation. So you have the real world of the property developers and the romantic world of the scientific community and somewhere between the two and in probably varying patterns of ingredients you have the science park.

81. There is probably a trade description point on that!

(Mr Heseltine) There probably is.

82. But in so far as one is talking about a genuine science park—and I think most people in talking about a science park would mean it has some connection with a university or a centre of higher education where there is an interchange between industry and academia—would you regard this as a desirable thing to be supporting or do you think it has no significance in the sense of the technology transfer process?

(Mr Heseltine) I regard the need to foster the partnership between the academic scientists' research facility and the wealth-creating exploitation of that as a very important aspect of the priorities that my Department would pursue. A lot of our activities have this in mind. Faraday is an extension of this. That is what led Dr Robinson and myself originally to have this conversation about whether we have got it right, whether there is more that could be done and whether we should be talking to other government departments about the same things, because there are lots of research facilities in other government departments doing work which may not be directly successful for wealth-creating purposes but which could have a wealth-producing spin-off. But in terms of the pursuit of public policy the DTI will be looking to see how we can augment the opportunities of the scientific community to help the wealth-creating community.

83. Would that include more academics, who are primarily employed in the universities, spending part of their time on exploitation leave as opposed to ordinary academic research sabbaticals, being able to spend more time in industry in order to pass on some of those aspects of technology?

(Mr Heseltine) That is a very sensible thought and in my own personal experience again—and colleagues may find it—you do find academics doing this on a significant scale. A lot of academics are in consultancies of one sort and another and in the wealth-creating sector it is a thoroughly desirable thing that they should when you get in the wealth-creating sector to projects where there is a great deal of interest.

(Mr Leigh) Could I say one thing on the science parks, which is an interesting question. We are launching a large-scale study jointly with NatWest Bank and KPMG of the tenants on science parks, the situation today compared with the situation in 1986, and the findings of that study will be available in 1993. So that should give us some useful insight into the success of the science parks. As you know, there were only two science parks, at Cambridge and Heriot-Watt, in 1981 and there are now 40 in the United Kingdom and 12 in the pipeline. So clearly the whole science park concept has been very successful and we are interested through this study in seeing how we can get some new ideas for the future.

Dr Bray

84. I am sure your science parks are successful. We have received a memorandum from Dr Walter Herriot, who is the Barclays Bank manager who was instrumental in the early stages of the Cambridge Science Park and is now with the St John's Innovation Centre, in which he says the failure rate of high-tech firms in St John's was only 4 per cent. in the first four years compared to a business average of 40 per cent., which suggests that well-managed high-tech firms in the right environment are a much lower risk than general scientists. Would you agree?

(Mr Heseltine) I would want to see a much wider survey where I would want to question whether one is comparing like with like. I would want to know whether a comparison between old-established firms going out of business and newly created high-technology firms just starting in business is the right comparison. I do not want to give the impression of any hesitancy in my encouragement of the exploitation of science. I am very keen on that but I do not want either to get into a position of giving a false impression that because there has been a success with scientific developments, somehow or other there is a logic that says I should be arguing that is the way that the whole of economy has to go. Undoubtedly there is a great opportunity for it but it cannot be to the exclusion of many other aspects of the issue.

Dr Bray: It is not a general point but a specific point in Walter Herriot's evidence.

Chairman: Can we turn to the matter of fiscal incentives for investment.

Dr Strang

85. Can I ask you about the role of fiscal incentives such as negative corporation tax for research and development by British firms. There is a scientific research allowance at present. How important do you see that? Could you also comment on the fact that the allowance only covers scientific research as opposed to development?

(Dr Robinson) The scientific research allowance is fairly tightly defined in terms of eligibility and, indeed, I know from my time at IBM we had to be very constrained in terms of our activities to make sure we qualified for the scientific research element. I also know just from my own experience that one has to be very careful about getting into creative accounting and making tax breaks the fundamental basis of your business decisions. So in terms of whether SRAs have been rightly defined or not, from my own experience I feel very comfortable with them. As we understand further the whole question of the exploitation of science, and whether tax incentives have a role or not, whether SRAs need to be reconsidered, it is too early to say. I know Dr Hicks has looked at tax incentives more particularly in terms of how they are used around the world for R&D.

86. How do we compare with these other countries?

(Dr Hicks) If you are talking about the conventional meaning of tax incentives for R&D, we do not have tax incentives apart from the SRA. A number of other countries do have tax incentives. For example, Australia has recently re-affirmed that it is going to continue its tax incentives.

87. Is there any prospect of the Government looking at the question of fiscal incentives to cover research and development in British industry?

(Mr Heseltine) You appreciate that this is essentially a matter for the Chancellor, and I do not think I can do anything other than acknowledge that I have an interest in this. I do not think I can give an indication of what decision the Chancellor may or may not take in these matters but there is a general policy around and that is that we believe that having got the tax regimes in this country down to a world competitive basis, it is right to allow decisions to be taken on their economic return as opposed to what are the fiscal advantages associated with that, but it is a general government policy in line with the low levels of corporation tax we now have in this country.

Chairman

88. But, President, you will be acutely aware that there is a highly competitive market to try to attract science into industrial activity and get a high flow of technological development and other countries appear to use other instruments, of which fiscal incentives is one. We cannot ignore it, can we, unless we are satisfied that it is a possibly harmful interventionist kind of policy?

(Mr Heseltine) No, we cannot ignore it, but I do not want to give the impression that there is an announcement imminent in this field. Of course, the arguments are well established. It is also true to say that companies of this sort would be eligible for regional support and I daresay that is something to do with why they have located so heavily in South Wales, Scotland and the North-East.

Dr Strang

89. Could I make one observation. There are obviously a lot of these. Would it not be advantageous when it comes to some of these large multinational companies investing in this country if there were special incentives to encourage them to locate their R&D facilities in Britain?

(Dr Robinson) Having persuaded IBM to do R&D in the United Kingdom, I can confirm that as far as that company is concerned, tax considerations never entered into it for R&D. I have recently visited a number of companies who are starting to invest in R&D in a relatively modest way in the United Kingdom, and in Japan last week I met a number of R&D directors and asked what factors made them choose to come to the United Kingdom for R&D investment, and tax was never in their consideration at all. So I think the companies that have successfully invested in R&D do not do it for tax reasons though there may be some marginal considerations, as the President alluded to, that could be considered. I think personally it would be a mistake to focus on that as the driving force for major R&D decisions.

Dr Bray

90. Clearly they would not have been influenced by tax incentives because there are not any. All the research and development can be written off 100 per cent. like any other business expenditure, but over and above that it is only capital expenditure for one purpose, that is, for the scientific research allowance. That is the case, is it not?

(Dr Robinson) Yes.

91. Are you aware of the recent survey by KPMG Peat Marwick on the interest of companies in tax incentives?

(Dr Robinson) Yes.

92. They found in their survey that 79 per cent. of firms said that present government incentives did not influence R&D commitment, but 86 per cent. of firms were in favour of a corporation tax incentive for research and development work, and their reasons are interesting: first, because it is more effective than present government schemes, and secondly, it allows the companies rather than government to have the say-so on what research is done.

(Mr Leigh) It is an interesting point but there have been studies on this whole tax relief issue - I believe an important study in 1987—which found

[**Dr Bray** *Contd*]

that they cost more in lost tax than they produce in genuine R&D. There is a fine judgment to be made here, and although you quite rightly refer to that study showing that some firms wanted tax credits, the cost of the tax credits is probably largely the DTI's support of the firms' R&D. Most money might go to the better firms, so it is an interesting point but it is less efficient. There are problems attached to it.

93. But that Inland Revenue study you referred to is hopelessly out-of-date. Since 1987 there have been two major changes and the two major new pieces of overseas evidence are from Australia and the United States. In Australia a 150 per cent. tax allowance has had spectacular effects and in the United States they have shifted the basis of their calculation of the incremental research from the increment on a sliding average over past years to an increment on an average over fixed past years, and the effect of that is to make it far cheaper in future to expand research there than in this country.

(Mr Leigh) The jury is out on this. We do not know what the experience in Germany is. If what you are saying is right, why is Germany so successful and their companies put such a large proportion into R&D?

Dr Bray: Can I quote evidence from a specific company. Perhaps you would check with them. GKN have located the bulk of their expansion in research expenditure in Germany because they say that although they pay scientists 50 per cent. more in Germany, it costs them less to employ them in Germany than in Britain.

Chairman

94. Perhaps that is something you would care to look into?

(Mr Heseltine) That is the difficulty. It is not a totally dissimilar argument to the one that argues for investment allowances in capital expenditure across industry at large and this is not something that, as ministers in the Department of Trade and Industry, we can give encouragement to, unless there is a change of government policy. We can discuss these matters within government. There are arguments that you rightly produced both ways, but what we cannot do is to give an indication that we are about to change government policy, with all the expectations that would arise if we were to do that.

Dr Bray: At least you might avoid quoting evidence which was out-of-date at the time it was published five years ago.

Chairman

95. I think we will move on to another subject, leaving that unanswered. President, could I ask you about company size and industrial innovation. Obviously larger companies and the spin-out from high-tech tend to have a good interrelationship one with the other but for small- and medium-size companies they may have different attitudes, different problems in associating with a new development and, of course, run-of-the-mill small firms may be ignored altogether. Could you tell us whether schemes that the DTI operate and the OST themselves take these differences sufficiently into account? Smaller firms and companies hopefully grow into medium and larger ones in getting attuned to industrial innovation and the spin-out from high-tech?

(Mr Heseltine) We have, of course, a regime which does cater for the smaller company, which is called SPUR, and one of the things we are looking at in the round, as I say, is this question as to whether our schemes are directly targeted, whether there are too many of them, whether they should be better concentrated. One of the issues we shall address is the issue of the small company. I think it is fair to say that for the very small company it may not be that they can carry the research programmes that perhaps would be better concentrated in larger companies.

96. Surely, but will they get the spin-off of the innovatory techniques which are developing?

(Mr Heseltine) One of the things which we will certainly be discussing with the larger companies is the extent to which they are using the trickle process of taking the technologies out into their supplying companies, and I have seen some of it happening in Japan. I have not the slightest doubt that for the small companies that is probably the most effective way of bringing them up-to-date, getting them used to modern technology and developing. There are small family businesses in Tokyo where the big company will provide equipment which is not perhaps modern but is a darned sight more modern than the company will use themselves, and will train them to use it and provide a whole range of services. There are companies doing that in this country but the idea is still rather new and we will do everything we can to encourage it. I have no doubt in that context technological advance will have its place.

Cheryl Gillan

97. President, many industrialists have argued that innovation depends on a continuous thread through the scientific discovery and innovative technology transfer and industrial exploitation, and some argue that abandoning the DTI near-market support has broken that thread and has been damaging to industrial performance. I wonder whether you agree with that view, and how can the position be changed without the DTI trying to pick winners, which I believe they did with moderate success in the past?

(Mr Heseltine) It is a very interesting question. I think it is now understood that in the sense that there is a market for all these things, if you produce a government grant machinery which removes itself from the near market, very rapidly people applying for the grant realise the way to get grants is to concentrate on non-near-market activities and that makes it easier to get the grants and you find

[Cheryl Gillan *Contd*]

yourself being driven further and further away from the market as people see this is where the thrust of policy is intended to go. This is an issue we have to look at. I am fully aware that the moment you move back towards the market you may find yourself doing things that the companies themselves should be doing. Indeed, you may find yourself doing things that some companies are doing and others are not doing and then you are faced with those sorts of base judgments as to whom you support and, equally, whom you do not. You could deal with that by having quotas on research activities. You do not deal with a specific project in a particular company. As Japan is doing in high-definition television, for example, you take 16 or 17 of the top companies and support that programme in partnership with the companies, but nobody would deny for a minute that the market is very far from concept involved, but the moment you start doing that again you are right up against the issue you rightly asked me about, which is backing winners. Of course, a lot of the firms are precisely in the business of making judgments about projects. If you look at the schemes that we back, we have to examine projects, we have to look at all the regional programmes. We examine projects. On the EUREKA programmes we examine projects, on aerospace we examine projects, there is no doctrinal division in all this matter except where ever you go you hit a range of problems. I would not advance public sector sponsorship as an infallible solution. There have been some very, very bad examples of how it has not delivered successful projects. When I did this equivalent job in the early 1970s we had the NRDC which invested in a whole range of projects and you believed it was making a profit but it was all on one product that mopped up the whole range of the projects.

Dr Bray

98. Like Glaxo?
(Mr Heseltine) Whichever it was called.

99. I am simply making the point that is true of a lot of successful companies, the pharmaceutical division in particular.

(Mr Heseltine) There are no ways of operating yourself out of these problems. Once you get into the business of using public money to support enterprises in any way you have problems of frontiers and involvement in the marketplace.

100. While I was reading through the papers I was a little surprised that the DTI memorandum restricted itself to UK support schemes. I could not find anything on international co-operation or the Framework Programme which I believe the DTI has been taking the lead in. Should not the Framework Programme and our own schemes be integrated and complementary in their compilation? What is your view of the Framework Programme? Is its transfer to OST leadership likely to lead to less cohesion of DTI objectives?

(Mr Heseltine) I do not think it will lead to less cohesion. You are quite right, the Chancellor of the Duchy does speak on our behalf and negotiate on our behalf because he has now the leading role as far as that particular part of the European Community is concerned. If one asks about the relationship between my Department and that of the European programme, well, of course we should have very close regard to avoid overlaps. I myself played some part in the past in trying to get co-ordinated European programmes because there is no point re-inventing the wheel several times over in several different countries if you can secure that; sometimes you can and sometimes you cannot. Again, it is not easy. I would, myself, want to enter something of a caveat about the European programme. I think there are questions to be asked there, just as there are about the work going on in my Department and we are asking them.

101. What do you think of attribution? I know many feel it is likely to lead to a distortion of the UK priorities and might discourage applicants from being involved in EC funding if receipts will be docked from domestic funding. I would have thought the purpose of EC R&D was to supplement national support schemes, and do not most other countries treat it in this way?

(Mr Heseltine) This is a perennial issue that arises between spending ministers and the Treasury. You will have seen the latest statement of Government policy made by my predecessor just before the election. There are things in politics where undoubtedly there are two sides of the argument and it will not surprise you if spending ministers take one view and the Treasury take another. That will undoubtedly be the case in Europe, but at the moment we have a given policy and I am here to defend it.

Sir Trevor Skeet

102. The DTI is involved in some 27 programmes involving the LINK Project, most of these are involved with the SERC but I notice only two are involved with the MOD. It is the MOD which receives a lot of research money, its very origin in the United Kingdom that we should deploy these resources and get them translated into products and processes. Do you think greater use can be made of the DRAs in the UK or have you any bright ideas which may bring the money forth and research forward?

(Mr Heseltine) Those are very interesting questions and, of course, I was once involved in the Ministry of Defence side of these discussions. Obviously changes are going on in the Ministry of Defence at the moment in the review of "Options for Change" and they will feed in their views into the OST White Paper and we will discuss their views in that context. I think as a general view it is not for me to speak on behalf of the Ministry of Defence but there is a general view we should constantly survey the work they do to see if there is a spin-off that can be enhanced from their science base. From the DTI perspective we would wish to ensure that wherever

[Sir Trevor Skeet *Contd*]

such a spin-off is available the possibility of it being exploited is taken into account. We cannot ourselves take decisions about the Ministry of Defence programmes, what we can do is talk to the Ministry of Defence about their programmes and see if they themselves are willing to recognise the exploitation factors associated with them.

103. Would it be helpful from your angle, the DTI view, if it is the Engineering Research Council which could foster these things?

(Mr Heseltine) Again, that is part of the review going on. I have an open mind as to whether there would be the gain to create another body but that, I think, is something which must flow from the decisions we take in the review taking place and then we can decide how the Department will actually implement the policies which flow.

Chairman

104. Would you feel there is a role here for OST because its remit must be one to see that the scientific base of the country is deployed effectively and if there is to be, for reasons we all understand, a reduction of defence commitment and thus a reduction in defence R&D the industrial applications or implications within their industry becomes a matter of national resource and national policy. Do you think the OST is the vehicle through which that kind of decision can be made?

(Mr Heseltine) Yes, I do, because basically OST will be responsible for the White Paper but it will be a Government White Paper, it is not something, I know this Committee will fully understand, that OST are going to produce their vision in the White Paper without reference to Government. Every word in their White Paper will be agreed collectively. That is the process now going on, the MOD and my Department will be involved. Why I hesitate in terms of engineering councils or anything of that sort is first we have to decide what we want to do and then to decide whether the existing machinery can do it. If it cannot we have to decide what alternative machinery is necessary. It does not follow that outside organisations are the right way to go, it may be but it does not follow they are. One of the things I am very keen on is to have greater input from the private sector world or the academic world in my Department actually administering the programmes themselves as opposed to double guessing those administering them having created some outside organisation. There is no absolute way of organising these things. We have now Dr Robinson from IBM, if it comes to him and he says the way to do this is to bring in more people from these companies who are used to taking these decisions, he will be pushing at an open door.

Sir Trevor Skeet

105. To what extent does the remit of OST run in your Department? If you take the case of Cullen in Oxfordshire, due to close very shortly, if they insist something should go on from there and your Chief Advisor decides it should be discontinued, is there not a collision?

(Mr Heseltine) There will have to be a collective decision.

106. There will have to be a collective decision?

(Mr Heseltine) Yes. First of all, if my Chief Advisor tells me this should happen I have to decide to take his advice. If I take his advice and it coincides with OST there is no need for any further discussion between colleagues because we have agreed whatever that decision amounts to. If, on the other hand, I disagree with my Chief Scientific Advisor and I am at odds with the OST I have the normal processes of Whitehall within which to decide how to resolve this dispute. In the end it would be a matter for me to decide how far up the sort of scale I push the argument.

107. Can I just push this a little further? The British National Space Centre is very very costly. I think the subscription, which is payable by you, is about £28 million a year. Now if you are going to make any cuts of any description, because you might be bound to, would you look at that? Would you look at big science in order to help small companies and other enterprises?

(Mr Heseltine) I have not got to the stage where I have to make such a decision but I would not start with the presumptions that I am there to help one particular section or another until I have examined all the options and it will be options not just within the research and development side of my Department, there may well be options I have to stretch across the whole of my Department. That depends on the resolution of the Public Expenditure Round but the usual practice—I will not go as far as to say it is always the practice—is once you have established a figure with the Treasury they will listen to most reasonable cases as to where the incidence of such a decision falls. It will be for me to decide where I want it to fall within my own Department. If I decided there had been enough on the R&D side then within a whole range of different arguments I would have to decide which one or which ones.

108. Can I have a final question: as you are a big one, and probably one of the most important ones of the lot, you will interface with many Government departments and many industries but pharmaceuticals does not come under your umbrella, that is the Ministry of Health. That is one of the most successful ones and in the United Kingdom, at the present moment, we have one or two very successful industries: pharmaceutical, petrochemical, oil industry and so forth. We have not got enough of them. Can you ginger up the rest and make them more successful by applying more research and so forth?

(Mr Heseltine) I think that just saying more research, if one starts thinking about what that actually means, would be to embark upon a journey of significant length. You have got to find the companies to do it and the companies with the

[Sir Trevor Skeet *Contd*]

capacity to exploit it, that in itself raises some pretty testing questions. You might well want to ask questions whether that is the quickest way to solve a gap in the balance of payments, might you be better getting inward investment of people who have already done the research and got the products in the hope once they come they will start doing research here. There are many ways of looking for answers. What I can give the Committee is this assurance that we are, and indeed we now have structured the Department of Trade and Industry so that it is in a position to ask those questions. That structure is now in place and we are now beginning the process of analysing and asking the questions.

109. Would you agree with Sir John Kingman of Bristol University when he says what we want from industry is the quality of management must be good and what we want from the universities is a complete line of graduates coming forth.

(Mr Heseltine) I think beyond macro-economics and the stability of low inflation, the low interest rate growth that delivers, I would myself put the quality of the training and education as the second item on the agenda that has to be addressed. If it had been addressed a hundred years ago we would have far fewer of the problems that we have today.

Dr Bray

110. On the relationship between the science base and industry application and competitiveness most of these questions seem to be looked into more thoroughly in the United States than in Britain. Are you aware of the study by Edwin Mansfield who looked at the innovations which could not have been carried out in the absence of academic research carried out in the last 15 years. Looking at just that narrow definition of recent academic research, the rate of return to be calculated to US industry and their customers was no less than 28% per annum, which is an extraordinarily high rate of return. Do you not think this justifies a higher priority for the science base than in recent years?

(Mr Heseltine) The answer to your specific question about the report, yes we are aware of the report and as to the issue of a higher commitment, well the Government's policy on that has been clearly spelt out. It is obviously something that has to be resolved in the Public Expenditure debate that goes on at this time of the year and I cannot anticipate the Chancellor's Autumn Statement. That we realise the benefits of the priorities of it is undoubtedly the case. Where that will rank in the inevitable and difficult judgments about priorities of public expenditure we have to wait until the Chancellor's Autumn Statement.

111. Is there not a case for doing similar research to that which has been done in the United States in Britain or perhaps in Europe to make the case for the levels of basic research that are strongly advocated by most successful industries, the pharmaceutical industry, the chemical industry, or does this advocacy seem to fall on stony ground?

(Mr Heseltine) We are not arguing that the case does not exist. We are very supportive of the broad thrust that there is a return to be achieved and it is an important aspect of the industrial base. The issue is whether the Government can afford more money. The private sector can afford what it can and it has greatly increased its scale of research and development which is much to be grateful for but in the end the issue is one of finite resources and very tight public expenditure constraints, I cannot change that definition.

112. We fully appreciate that anything which shows a rate of return of 28% is something you have to try to secure, you can go along to the Bank and borrow provided you make a good enough case.

(Mr Heseltine) If you can show 28%, you do not need to come near Government on an annual basis.

113. This is Government funded basic research.

(Mr Heseltine) If it is capable of making 28% on its money, you do not need Government research, you just do not need it.

114. I hope you will read the report for yourself.

(Mr Heseltine) Yes.

Mr Batiste

115. I was going to raise this a little later but as Sir Trevor Skeet has mentioned BNSC and the National Space Agency perhaps I could raise it at this stage. I think you may be the Minister who set up the European Space Agency originally and you now have SERC under you in DTI. This was set up in order to cover the difficulties of areas of research and development which cover a number of different areas of Departmental activities and try to co-ordinate these activities. Do you regard SERC as a successful organisation?

(Mr Heseltine) It is the best we can achieve in this country with very limited resources. I was, as you rightly say, in 1972 responsible for the space policy and it became apparent to me there was a very limited role that a national economy of our size could play in pushing to the frontiers of space. We had a whole range of different organisations scattered across Europe and scattered across Britain to deal with this. I was able to persuade my European colleagues to set up the European Space Agency. I believe it has worked to the advantage of this country. At that time I was not able to persuade my colleagues to set up a National Space Agency. That came later when I was in the Ministry of Defence because the Ministry of Defence was actually opposed to the concept of a British policy and a European policy at the time about the European Space Agency. It was not until I got to the Ministry of Defence that I was able to persuade them perhaps I was right all along. So we got the National Space Agency with the Ministry of Defence co-operating on it. We have taken steps there which draw together the British Space endeavour. It makes sense but it is not a very large endeavour in terms of international presence I have to say.

[**Mr Batiste** *Contd*]

116. I was talking pre-eminently in the nature of the mechanism it establishes with the leading Departments covering a range of contributions from other Departments as we are all pulling things together. Increasingly it appears R&D covers a very wide spectrum and part of the problem is trying to get a clear coherent approach to this. Do you see this mechanism having a wider application outside space?

(Mr Heseltine) In a sense the space mechanism is not that different from OST except OST is now doing R&D across the field and the Space Agency does space across the field. It is the same thinking. It is a co-ordinating agency in the sense it cannot give orders to the Ministry of Defence but there is a co-ordination of policy through which it, I think, has got a wider application. I have always argued for the concept of an OST. I think it is very important if only to get a common set of disciplines that are applied to measure the values you get from the research you are committing. There will be all sorts of different priorities but at least there should be a Government Department working out whether like with like is being compared in the priorities being established and, secondly, whether the basic questions are being asked about the exploitability of a particular product that is being achieved. As I understand the concept of the OST, which is in its infancy, those are the sorts of questions it will ask and because it exists on a trans-Whitehall basis it will be able to ensure it gets answers to those questions. I do not think those questions were asked in the absence of the OST. I remember this debate going on ten years ago.

Mr Powell

117. Your Department in the past has run a scheme for strengthening industrial liaison organisations, how do you evaluate that particular scheme?

(Mr Heseltine) Again, this comes under the general examination we are doing. The theory is first class. I am very keen, as I think we have dealt with in earlier questions, I am very keen to draw together academia and the industrial world. As in my own Department the precise workings of the scheme, that is something we must examine and in the context of the White Paper review decide to defend or to change.

118. You are not able to give us any glimpse as to whether you expect to make any changes?

(Mr Heseltine) No, I cannot. We are looking very comprehensively at the way in which the Department is dealing with its research and development programmes.

Cheryl Gillan

119. I have just got three little short questions. The advisory bodies for OST, especially ACOST, previously some would have some responsibilities which have now passed to the OST. How do you intend to ensure these advisory bodies have sufficient industrial weighting?

(Mr Heseltine) You can only do that by determining who you put on them. If you want industrial advice you put on industrialists. Those of us who have set up these bodies know it is a very time consuming business, trying to find industrialists who have the time and the experience to give to it.

120. Likewise, on appointing those people to those advisory bodies, do you think more consideration should be given to younger scientists and engineers, particularly those who might be at the leading edge of the industrial environment?

(Mr Heseltine) I would be a bit sceptical, perhaps I have a vested interest in this, but I do not automatically assume because they are younger they have a monopoly claim to public appointments. You must balance the judgment and determine the contribution the person can make, I think on grounds which are not to do with a person's age. That does not mean to say young people should not be involved, there are a lot of bright young people and they have a contribution to make. We should not get to a point where you assume once you get to a certain age you have no contribution to make.

121. Lastly, now we have a Commons' Science & Technology Committee, would it be desirable for the Committee to take advice from a body like the Office of Technical Assistance, the OTA, which I understand provides advice in the United States?

(Mr Heseltine) I think it is entirely for the Committee to decide how it should organise its advice. Within the British system there is no shortage of advisory bodies and no shortage of people prepared to give advice. We have a very obvious relationship with Committees such as this. I doubt if it is a shortage of advice that is our problem.

Chairman: Can we now turn to the vexed question of intellectual property rights.

Mr Powell

122. The Patent Office is a Next Steps Agency, it is viewed as executive rather than as a policy formation body. Is the creation of a Next Steps Agency of this sort, is this in any way inhibiting development of concentration on potential policy problems in the area of intellectual property?

(Mr Leigh) No, I think its intellectual property is very important, worldwide trade is worth about £10 billion a year we estimate. I think we have great confidence in the agency concept and, indeed, moving forward to a trading fund concept I think it is right an organisation like the Patent Office should have as much independence as possible from the central bureaucracy of the DTI. We are responsible for the overall policy making but the Patent Office although a Governmental organisation, and undoubtedly it will remain a Governmental organisation for the foreseeable future because it is afterall a monopoly granting monopolies, it is difficult to see how it can be anything other than Governmental or a Government owned organisation, although it must remain in the public sector, at

[**Mr Powell** *Contd*]

least for the foreseeable future, I think it is right it should have as much independence as possible from the DTI. We are very pleased with the progress made in its new independent role.

123. I do not think that answer goes to the heart of what I was putting to you and that concerns policy formation. The Patent Office is essentially an executive agency which is administering existing law and intellectual property law is developing all the time and involves enormous policy considerations not confined to this country. I am interested in whether you are satisfied having hived off the Patent Office you actually have the policy formation units which are satisfactory and which are working properly, not only here but across the frontiers within your own Department?

(Mr Leigh) Hived off is not entirely correct. They have to provide a corporate plan which has to be approved by ministers, ministers who lay down the framework in the general interest. The Patent Office, like other executive agencies and trading funds, is out there in the marketplace and it is right they should have that degree of independence we give them subject to having to give us a corporate plan of which we approve.

Chairman

124. Could I press a little further on that. There is some anxiety expressed that the intellectual property regime in the United Kingdom, and to some extent in Europe, is not really compatible or not very well suited with that available in other countries, particularly the United States. Are you satisfied we have a system irrespective of hiving off, or an agency, or Next Steps, have we a system which will be properly productive of scientific development?

(Mr Leigh) There is always room for improvement but our information suggests to us the UK Patent Office compares very favourably with other patent offices. We would look for further improvement and for more efficiency in the organisation but there is no evidence to suggest our patent system is inferior to any of our European competitors.

(Mr Heseltine) We have considered the legislation in relation to this.

(Dr Hicks) There are a number of changes in prospect to the IPR system, for example the US patent system which allows prior publication, is under review and there are currently negotiations at international level at the moment, to bring various national systems into line.

125. That would be most helpful, would it not, people would have comparable terms?

(Mr Heseltine) This is one of the issues which is current as to whether we can legislate to deal with this.

126. Yes. The point is on board.

(Dr Robinson) The current sense is the US is looking very hard at coming into line with what the rest of the world is doing. Those debates are quite well advanced.

Mr Batiste

127. The legislative aspect of policy change remains within the Department rather than in the Patent Office?

(Dr Robinson) Yes. It rests with Ministers.

128. You are happy that the communications are adequate and where the marketplace requires some change, as with the differential in the United States system, there is no inhibition in the process for getting that legislation through?

(Mr Heseltine) I think it is important to understand agencies are executive agencies carrying out agreed Government policy. They have a corporate plan to establish what that policy will be, they have to agree it with us and if they wish to change policies we can direct them if it is within the law and they can carry it out, but if not we will change the law. It is for the Ministers to determine, in this case DTi Ministers. As I say we have had conversations about that. It is under active consideration.

129. Well, staying with intellectual property rights, there was concern some while ago within the universities particularly, one of the problems for successful technology transfer was a major uncertainty about who owned property rights, how the fruits of them were divided up. It was suggested more recently the universities have come to terms with this and that has been sorted out.

(Dr Robinson) Yes, it has been an active debate and we have been encouraged by the way the universities have taken a proprietorial interest in the intellectual property side of things going on in their campuses.

Sir Trevor Skeet

130. Is he aware the Chemical Industries Association have put this as a major issue, the need to develop a regime for intellectual property rights for bio-technological inventions? Would he have anything further to say on that and whether he is prepared to extend terms of the patents to enable companies to redeem some of their development costs?

(Mr Heseltine) This is precisely the sort of issue the chemical industry will, I hope, raise with us through our central working party and if we are persuaded then that is exactly the sort of role I see the sponsoring department pursuing.

Chairman: Can we now turn to priorities in research funded by Government Departments.

Dr Bray

131. Accepting the point that there are limited funds, there are obviously particular areas of research which have to be abandoned and there may,

[**Dr Bray** *Contd*]

therefore, be a case for going for fast breeder research within the UK but might that not also in itself constitute a case for maintaining a European programme of research?

(Mr Heseltine) Yes, there is a case for Europeanising research because it stops you re-inventing the wheel provided you do not lose control of the policy and providing the exploitation of policy is not so removed from the self- interest of your companies that you have done yourself damage. There are not simple answers to this question. If you take the obvious issue, supposing we have a technological lead in this country and we Europeanise the programme, the effect of that starkly is to transfer to our competitors the technological lead. That is a very nice generous thing to do but it is not real politics and nobody would do it to us and I have to confess I would not be the first to try and do it at the expensive of British industry. You have to weigh these things out very carefully if there are projects which are beyond the budgets of the individual national States where we can co-operate and where we can protect the interests of the companies concerned. I have played my role in the European Fighter Aircaft, the European Space Agency, the IAPG in the Ministry of Defence in developing these subjects. However, negotiation is fraught with the national self-interest of the companies concerned. The general view I would put to this Committee is no nation is going to make progress in this direction unless they can see how it benefits their own national companies. That is my experience. I think it is the real world. I would not allow myself to get caught up in generalisations which try to hide the real politics of industrial co-operation.

132. I am not asking you to generalise, I am asking you to say something about the particular case which is falling for you to review under the general energy policy and coal review which you are now carrying out. I take it you are not proposing to rehabilitate a UK fast breeder reactor programme comparable with the French? I am asking you: are you proposing to withdraw even from the European programme?

(Mr Heseltine) I have just checked up my memory on this. We are now looking at this programme and we are discussing the position with the nuclear industry. It is therefore under active consideration.

133. Withdrawing or staying?

(Mr Heseltine) The policy is under active consideration.

Chairman: Right, the policy is under active consideration.

Sir Trevor Skeet

134. And not decided yet?

(Mr Heseltine) And not decided yet.

Chairman

135. Could I just amplify the background to the point Dr Bray was making, the question of what constitutes the broad central direction which your Department gives to the technologies which you know are being developed by other Departments or which have been developed by the DTI but over time are now no longer, as it were, given the first priority. Do you actually have a central direction which other committees might use to identify priorities which all Departments then agree to? Is there a way by which you arrive at the central priority?

(Mr Heseltine) I think that what is happening at the moment, I referred to the conversation I had with Dr Robinson when we first met under this roof and we are thoroughly reviewing the efforts of my Department, particularly in the context of the OST White Paper. The present situation is it is being explored at official level, the options are being prepared, the analysis is being undertaken. Dr Robinson has not yet come back to me and said: "Here is the horizon in which you are operating, these seem to be the options arriving out of this present status quo." I appreciate from the point of view of this Committee that is not a helpful thing to say because I cannot answer a great number of questions which are of legitimate interest to you. We are at a formulative stage in which these things are being carefully analysed. They will come to me probably some time after Christmas and that will be part of the process of my determining what I have to say to OST. I may not be able to carry OST or my colleagues with me. That is where I have to start. At exactly the same time the OST will be drawing the other Government Departments into the framework of the White Paper and we, from the DTI, will have an input into that process. All I can do today is to read to you what the objectives of the DTI were at the moment when I took over responsibility for it. At the moment I am carrying on the programmes until I make up my mind how or where we should change them.

Sir Trevor Skeet

136. When the President mentions in connection with European research that he does not want to re-invent the wheel, is he citing a case for subsidiarity in research?

(Mr Heseltine) I hope if I can define subsidiarity as national self-interest then I can assure you, Sir Trevor, that will be the driving motivation behind what I do but so will it be the driving motivation behind what other Ministers in the European Community do. It may not be the language in which we evolve but the motivations. If there was an argument for helping British industry or supporting UK based companies then that is where my responsibility and priorities have to be. If I feel I can help them more by co-operating with other European companies I will do so. That is an escalating process. You do not start by saying: "Let us draw the whole thing into a pool and see what comes out." You start with companies you have got,

[**Sir Trevor Skeet** *Contd*]

putting them in the pool and they exist and build up. You say this is ridiculous, for example the Japanese are outstripping us because they are better co-ordinated or have so much better resources or the Americans. Then you might say: "Let us put ourselves in a more coherent framework", and you may start to do partnerships with the Japanese which flow from that. You start with a national base of national money, national science and national companies and work out to see where the best advantage flows.

Mr Strang

137. Is that review looking at the extent to which the Government should fund applied as opposed to basic research? Is that within the remit?

(Mr Heseltine) I think it must come within the remit. As I was saying to Cheryl Gillan we have to ask questions whether we are getting the most value for money out of this endeavour. In saying that, which is a very frank answer to you to a straight question, I do not want to give the impression I am moving in that direction but I am prepared to ask a question.

138. Do you expect the Government's White Paper to give a clear steer on what the Government's thinking is on that?

(Mr Heseltine) Indeed.

Chairman: Could we turn to co-ordination with research councils?

Sir Trevor Skeet

139. I covered this point earlier when I mentioned about the pharmaceutical industries which are outside the responsibility of your Department and I was wondering what links you had in order to improve the interface and what impact you have with the OST which is also responsible for the overall lead?

(Mr Heseltine) Perhaps I should have said to you when you asked that question before it is perfectly true that the public health does sponsor pharmaceutical industries but I sponsor the chemical industry and as very largely they are the same companies it is quite difficult to distinguish often as to where that line should be drawn. I have to say at once there is no problem whatsoever in Whitehall. I just want to give the impression I am very closely in touch with the sorts of companies that are both chemical and pharmaceutical and so I discuss these issues with them and our sectoral sponsorship role would not be able to avoid doing so because they would say: "How can you talk about companies without looking at our responsibilities and so on." Having said that, I cannot take the Committee any further in terms of the way in which new machinery or new policies will develop because that is inevitably a part of the White Paper process.

Chairman: Going briefly on to the subject of energy, Mr Williams?

Mr Williams

140. Could I ask first about the procedures of decision making within the DTI? You will know research councils do a peer review for deciding on relative priorities and on distributing its budget, but what element of the peer review is within the DTI's decision making?

(Mr Heseltine) Yes, the peer review system is useful, when there are no external objectives you can compare your policy with. We at the moment have financial criteria, for example, we have criteria and, therefore, we can say how does a particular project measure against our criteria. Where peer review seems to have a more relevant presence is where you have not got a criteria and, therefore, you have the pure science, for example, which is perhaps at that stage and you are forced back to a peer review system.

141. Could I move on to energy research and development. I understand the DTI has now taken over responsibility for that and there is a budget there of something of the order of 150 million a year. Would you accept it as a criticism that over the years there has been too little emphasis on alternative sources of energy, too much on nuclear research, and last year we had the exclusion of clean coal combustion, that the project in Grimethorpe seems to be running out of funds.

(Mr Heseltine) As you know, on the question of the alternative sources of energy, I am now conducting a very comprehensive review into all these issues and the points you raise with me will have to be covered in the review I promised to the House some time in the new year. You are right in saying we are responsible for energy research. It is not the largest body one could envisage and it has to cover a wide range of fuel possibilities, but the extent to which we wish to change energy policy and, therefore, perhaps redirect the energy research must flow from the review that is taking place.

142. Is there an argument for having the peer review parallel? Is there an argument in the energy policy to redirect something along the lines of the Energy Commission back in the 1970s where representatives of a whole variety of energy sources, energy consumers and industries could be involved in policy formulation and then in energy research and development as well?

(Mr Heseltine) We have an advisory panel which plays a role in this but I have not detected within the Department the inability to design policy. People may not agree with the policies we have designed but we have policies, we have energy policies, and we are now conducting a review to open up the whole range of issues which are presently closed. I do not find myself in any way unable to get advice or deprived of the Civil Service to get that advice. The fact is in the whole energy debate there are irreconcilable conflicts. There are people who believe passionately in one form of fuel and people who believe just as passionately in another. Whatever you do you will never bridge the conflicting arguments. In the end

[Mr Williams *Contd*]

you have to make a political judgement about the priorities. I do not feel myself I am short of the advice or capability upon which to do that although the decisions themselves may be controversial.

143. Could I just ask finally and specifically, on the clean coal combustion project in Grimethorpe we have had. Dr Bray earlier emphasised the importance of FBR research and European FBR research that could be a long term source of electricity and energy, similarly the alternative is clean coal combustion because gas and oil resources will be gone by the end of the next century. Britain did have the world lead in that technology ten years ago and other countries had an interest in it. It is sad to see the project in Grimethorpe running to ground when in the other countries in the longer term they are hot on research.

(Dr Robinson) Yes, I think as the President said the whole energy policy is under review but the subject of the Grimethorpe experiment and the topping cycle to which Mr Williams is referring was referred to our independent advisory panel who advises us on R&D priorities. They said within the scheme of what is affordable they did not give that a higher priority given the amount of money it would cost. Again it is a question of the amount of money that can be spent. I think the figure was of the order of £100 million over the next several years to fund that project. In the scheme of priorities I am afraid it did not make the grade as it were.

(Mr Heseltine) Am I not right in thinking the Americans are spending a huge amount of money on this project?

(Dr Robinson) There are a number of developments going around the world. A lot of people are claiming they will have technology which is yet to be verified.

144. In the same way as the FBR matter is under consideration in your Department I am certain in my own mind in 20 or 30 years' time we will be buying this technology back from the Americans or whatever it is that is going to be sacrificed. We should, as part of that energy review, I understand the Select Committee on Energy did recommend that last year, I wish your Department in that review could reconsider the question of clean coal combustion.

(Mr Heseltine) I am aware this issue on the work programme which we have drawn up in the Department of Trade and Industry, I am aware this particular subject has to be covered.

Mr Batiste

145. Can I revert to Mr Williams's first question on the peer review question. As I understand it your answer was that where you were dealing with blue sky research, peer review could work very well, where you are criteria led your choices are more obvious. For many of your schemes there will be more applications for support than there will be funds available to support them, so judgments effectively have to be made between competing applicants which will fall between your criteria. If I understood you right earlier you said where you needed industrial advice you could bring it in, there was no shortage of it. I suppose part of the problem is as you resolve arguments about how close to the market place you are, the nearer the market place you become the less reliable it is to get businessmen in who if they have knowledge of the subject have a vested interest in it.

(Mr Heseltine) I think this is dealt with in other parts of the Department. We have the innovation unit which is very close to the market place. We have advice on regional policy which comes from the private sector where specific grants are involved. Government have dealt with these issues using advisors in the distribution of specific grants through my Department over many years. It can be done. I think the important point about the peer review is that is a system more appropriate where you have not got laid down criteria on which to define the proposal.

Dr Bray

146. As you say, DTI does have a continuous programme of evaluation and assessment of particular programmes and I certainly would not criticise the thoroughness with which those investments are carried out. Is there any comparable criterion, any comparable external objectives, which applies to the task of DTI as a whole in contributing to the improvement of technological competitiveness, particularly in the context of economic objectiveness which you outlined?

(Mr Heseltine) You mean is my Department subjected to peer review?

147. No, I am saying do you have any standard against which to measure the aggregate of your Departmental policies?

(Mr Heseltine) No, there is not. I am working on the publication of an annual report by the Department.

148. Is there not a danger of your just fiddling while Rome burns? You are playing with small change.

(Mr Heseltine) It would be fair to say in the years in which you and I have sat in this House, I am not aware of any peer review process or independent assessment of any Government Department process in any Department I can think of.

149. There is tucked away in the Treasury model on the manufacture of exports an assumption of technological competitiveness in the UK, after allowing for world trade, and that is deteriorating at a rate of 2% per annum, that is £2 billion per annum lack of growth in manufactured exports. Is that a relevant criterion against which to judge the DTI's adequacy and interest in technological processes?

(Mr Heseltine) No. The relative decline of the nation's industrial base is attributable to many

[**Dr Bray** *Contd*]

factors but it would be quite wrong to try to single out the DTI as the only factor; that would be an excess.

150. It is not a question of it being the only factor, but in so far as technological competitiveness of manufacturing is more interesting to the parish of the DTI than in any other Government Department?

(Mr Heseltine) I do not even agree with that. You could argue whether I personally put macro-economic stability at the top of my list. I would not hesitate to put education and training as number two on my list but you could advance through that list through 1,000 different items: industrial relations, management quality, a huge range of things you could put on that list. It is a very interesting discussion and it is very important we should analyse these things and try to get them right in the future. One of the things in the Department I am responsible for is how limited the role of the Department is within its own control. That it can influence other departments which have much wider influence, that is the case within money we spend or the policies for which we are responsible, it is within our own control and influence and the impact of the Department of Trade and Industry is relatively limited.

151. Whether the actual delivery of the policy comes through your announcement or the Chancellor's announcement about tax incentives, are you saying get the economy stable, get training and education right and competitiveness will automatically be achieved?

(Mr Heseltine) No. I said there are a thousand things on the list but very few within the Department of Trade and Industry's immediate gift. That is not to say we cannot influence them because we go back to other departments. If you back research and development, as we are discussing here now with the OST, the Department of Trade and Industry only has a part in the development programmes there, they are spread widely across Whitehall.

152. You have no measure against which you can test your progress from year to year as to whether your influence, direct or indirect, is in any way related in scale to the magnitude of the challenge.

(Mr Heseltine) No.

Chairman

153. On the other hand, President, you have made it clear anything that can be done to improve the competitiveness of British industry and to give a higher priority to industrial development is something you will be willing to encourage?

(Mr Heseltine) Absolutely.

154. Whatever may be the lack of powers you have, the direction in which you wish to see it go is to spend more on R&D and to spend more on technology and developing suitable new technologies for the market place?

(Mr Heseltine) Within the gift of the Department of Trade and Industry. We have to improve our performance. I was addressing the specific question is there a benchmark to compare the success applicable to Department of Trade and Industry which relates to the success of the trading economy. The trading economy is the product of a whole range of Government Departments. You can measure the success relatively of the trading economy, that is perfectly true, vis a vis other trading economies but that is the product in part of Government policies and in part the private sector and those working in it.

Dr Bray

155. Supposing the Treasury were to say: "Yes, we are in favour of stable interest rates of growth and a lower level of unemployment, but while that is our objective we cannot say if inflation will be 15% one year, 2% the next and then up to 15% again, that is beyond our ability to control", would you be happy with a regime like that?

(Mr Heseltine) No, of course I would not.

156. How can you reject the relevance of that kind of test against an area for which you do have particular interest, and that is the technological competitiveness of manufacturers?

(Mr Heseltine) Well, first of all, I do not have sole responsibility for technological innovation or policy in my Department because it is a Government-wide activity. Secondly, in terms of looking at the overall output of these policies there are a myriad of other factors that come into play. We might invent things that have been sponsored by my Department, you could argue that is the judgment of my Department and we should get credit for it, but sponsoring the invention is not exploited. You can think of a whole range of reasons why it would not be exploited but it would be quite outside the control of my Department.

157. Are you saying you hope a successful industrial performance will come from somewhere? You have said in the past you would like to see an industrial strategy, are you now saying it is not going to come from DTI or yourself?

(Mr Heseltine) It will come from the performance of the economy. I have explained my view about industrial strategy. I have used the analogy of a dozen organ stops and those organ stops have to be in tune to the maximum extent in order to achieve the result we are talking about. If I give a factual example of what I mean, the German economy has not stripped ahead of the British economy in one given year or in one given direction, it has stripped ahead of us at the rate of about 1% a year, by and large it has done it for most of the post war years. If you do it consistently for that period of time you find you have an economy of double the size in Germany of the British economy. The ingredients of that 1% aggregation are spread throughout the social system: the trade union relationships, the relationship of the

[**Dr Bray** *Contd*]

management and the workforce, the banking relationship, the research relationship, the DIM system of Germany, the allocation system, the training of middle management, the training of engineers, it is an accumulation of a whole range of policies which add up to on average 1% better than the British economy. The Department of Trade and Industry trying to match that is only part of the process. I in no way wish to stand apart from the process but it is as a Member of the Cabinet I would have to account for the relative performance and not as a Departmental Minister.

Chairman: I think, President, thank you, you have drawn the matter to a conclusion at this point. May I thank you on behalf of the Committee and your Minister, Edward Leigh, for being with us, for answering questions and spending a considerable time on your own vital role on our economy and the role of your Department. Thank you very much indeed.

THURSDAY 5 NOVEMBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mrs Anne Campbell
Cheryl Gillan
Mr William Powell
Sir Trevor Skeet
Dr Gavin Strang
Mr Alan W Williams

Memorandum submitted by the Natural Environment Research Council (25 September 1992)

1. WHAT STRUCTURE DOES THE GOVERNMENT NEED TO ADVISE IT ON SCIENCE POLICY?

1.1 Given that Government has a finite resource for funding science and technology (S&T), the structures for the development of science policy and the allocation of Government funding need to reflect the various purposes for which research and postgraduate training is supported and the methods by which that support is delivered.

1.2 Government needs to be advised on its support for:

(i) The science base, operated through the Research Council system and also through the Higher Education Funding Councils (HEFCs). In this context support for the science base encompasses research, survey and the provision of trained scientists and engineers.

(ii) The research and survey needed by Government to inform its own policy and regulatory objectives and to support its procurement decisions, the generic research needed to advance technology and provide a base for industrial success, and that research needed for defined areas of national need related to the public good. Such support is primarily delivered through Departmental commissioning programmes.

1.3 The Mission of the Natural Environment Research Council (NERC) (Annex 1) gives it a locus in both these areas. It is involved in the science base, as a procurer of research and training in the Higher Education Institutions (HEIs) both in responsive and targeted mode,[1] and as a provider of research output through the targeted activities of its own research institutes and units. NERC also acts as a contractor to Government Departments for their specific research programmes.

1.4 NERC considers that the present structures could be improved at the interface between support for the science base and support through Departmental programmes, and also at the interface within the science base, between research Councils and the HEIs. The capacity for responding to Departmental needs depends on the health of the science base. The capacity for HEIs to respond to high priority science needs identified by the Research Councils depends on considerations of selectivity and concentration developed by the HEFCs.

1.5 In the present structure The Advisory Board for the Research Councils (ABRC) is concerned primarily with science supported by the Research Councils and has no cross representation with the HEFCs; the various Departmental Advisory Bodies, where they exist, are concerned with science for Departmental needs but do not routinely have representation from the Research Councils; the HEFCs are concerned solely with the HEIs. Nowhere has there been an effective bringing together of the interests of all these various bodies. They each put up bids for new support through their respective Departmental lines in isolation from each other. Present mechanisms may not exploit the full potential for interaction between related interests and bids.

1.6 The following proposals are aimed at addressing this problem. They also suggest that there could be merit in introducing a distinction between the structure that provides independent advice to Government on the broad strategic framework of research requirements, and the structure which brings together the interest groups bidding for Government resources.

Bidding Structure(s)

1.7 Since one of the stated aims of OST is to help the Government take decisions on S&T priorities in the Public Expenditure Survey (PES), it is assumed that OST has, or will be developing, a mechanism for bringing together all the S&T bids entering the PES process so that their inter-relationships and relative priorities may be assessed. This mechanism needs to be made transparent to the major players.

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[1] See Appendix for definitions.

1.8 NERC would suggest the need for greater interaction between the various bidding agencies before that stage and would propose that a reconstituted (and renamed) ABRC, involving representatives of the HEFCs as full members, could provide an appropriate bidding structure for the science base. This would deal with the HEFC/Research Council interface referred to in paragraph 1.4 above, but would not address the interface between the science base and Departmental S&T programmes.

1.9 If Departments were able to put their own forward plans and bids on the table together with such a forum, then a single structure incorporating full Departmental membership as well could be established. Realistically, however, such an all embracing structure could prove too unwieldy unless it met only once or twice at appropriate times in the PES cycle. NERC would therefore opt instead for a Board for the Science Base (BSB) involving the Research Councils and HEFCs in partnership, together with full membership of Research Councils on relevant corresponding Departmental Advisory Bodies, which would need to be created in certain cases.

1.10 Within such a system there would be merit in retaining the annual meeting of the BSB with Chief Scientists and Chief Scientific Advisers of the Government Departments with major R&D budgets that has been instituted within the present ABRC.

National S&T Requirements Structure(s)

1.11 NERC considers that there would be some advantage in bodies providing advice to Government on its longer-term strategic aims in supporting S&T being distinct from those with executive responsibility for delivery of research and training. Government could also call on such a body, if it wished, to advise on competing bids for resources coming up from its various Bidding Structure(s). There would need to be a majority of independent members on any such group. A reconstituted Advisory Council on Science and Technology (ACOST) could fulfil such a role.

2. ARE THE EXISTING BODIES (SUCH AS ACOST, ABRC AND THE FUNDING COUNCILS) APPROPRIATE?

2.1 Yes, although we believe some change is desirable. The existing structures work, as shown by the Government's record for the support of the UK's S&T over the recent period of high inflation and recession. What we propose is how, in our judgment, these structures might be improved by changes in terms of reference and constitution. The need for change is prompted by the separation of Departmental responsibility for Research Councils (to OST) and HEFCs (to DFE), by the need for an overview of government supported strategic science (funded by Research Councils and Departments) and in order to separate those advising on what the science base can offer from those advising on how such a bid meets the requirements of the Government.

2.2 The ABRC at present provides a focus for the five Research Councils and for promoting cross Council collaboration. There would be a continuing need for such a focus unless the Research Council system were to be reorganised. The current ABRC's strength lies in its ability to advise Government on the health of the science base, what it can offer and to prioritise bids for additional resources. But the creation of the OST has led to the HEFCs contribution to the support of science base being considered separately, via DFE.

2.3 In paras 1.8 and 1.9 we suggest the reconstitution and redefinition of ABRC as the Board for the Science Base which would act as the bidding structure for the science base as a whole. This would require re-introduction of cross-membership with the HEFCs.

2.4 The scenario does however suggest that the wider responsibilities of the present ABRC in terms of advising Government on civil science, the balance between national and international activity, etc., would be more appropriate to a smaller reconstituted ACOST as the independent national S&T requirements body.

3. IS THERE A NEED FOR BETTER CO-ORDINATION IN FUNDING POLICY FOR HIGHER EDUCATION INSTITUTIONS BETWEEN THE RESEARCH COUNCILS AND THE FUNDING COUNCILS? IF SO, HOW IS THIS TO BE ACHIEVED?

3.1 It is important for the HEIs to continue to receive, through the Funding Councils, resources to enable the pursuit of a degree of speculative and innovative research quite independently of funding from the Research Councils.

3.2 However, at the same time there will continue to be many common areas of science policy interest between the Research Councils and HEFCs, for example in relation to questions of research selectivity and concentration and the provision of trained manpower.

3.3 With the separation of responsibility within Government for the HEFCs and the Research Councils it will be even more important to ensure that good contacts are established and maintained between the different Councils. The above proposal (paras 1.8 and 2.3) for a reconstituted ABRC involving the HEFCs would help. There should in addition be representation of Heads of Research Councils on the HEFCs.

4. WHAT SHOULD BE THE FUTURE ROLE OF ACOST AND IS IT APPROPRIATE FOR THE EFFECTIVE CHAIRMAN TO CONTINUE TO BE AN INDUSTRIALIST WITH A TECHNOLOGICAL BACKGROUND, OR SHOULD THE MINISTER TAKE THE LEAD?

4.1 Now that the Government has established a clear Ministerial focus for science within the Cabinet in the person of The Chancellor of the Duchy of Lancaster, it would seem more appropriate for a reconstituted ACOST to report to The Chancellor of the Duchy of Lancaster rather than direct to the Prime Minister.

4.2 In para 1.11 above we propose that a reconstituted ACOST should be the primary source of independent advice to the Chancellor on issues relating to science policy and the strategic aims of Government in supporting S&T. It should be charged with taking a longer-term look at such issues than that imposed by the constraints of the three year cycle of the Public Expenditure Survey and of five year parliamentary terms, and operate more openly than in the past, inviting evidence and publishing its reports as a matter of course. We also believe that the national academies for engineering, medicine and science could be used to greater effect in providing policy advice.

4.3 A reconstituted ACOST should be concerned equally with those S&T activities and issues contributing to wealth creation and to the public good rather than tending to focus more on the former as has been the case in the past.

4.4 Its members should be required to make a regular commitment of time (e.g., one to two days per week) to its activities and be rewarded accordingly.

4.5 As an independent advisory Committee it will be important for the Chairman to be independent of Government. The Chancellor of the Duchy of Lancaster should not take the lead therefore, although he may wish to meet periodically with the committee as has the Prime Minister in the past. There is no *prima facie* reason for the Chairman of a reconstituted ACOST to continue to be an industrialist with a technological background. Whilst such expertise is needed on the committee the Chairman could equally well be an academic with a strong background in strategic or applied science.

5. CAN ANY PROBLEMS WHICH AROSE FROM THE PREVIOUS WAYS IN WHICH SCIENCE POLICY WAS CO-ORDINATED BE IDENTIFIED?

5.1 In para 1.4 we referred to the need to ensure satisfactory exchange of information across the science base/Departmental interface. A number of *ad hoc* arrangements have been necessary to develop co-ordination of research programmes across this interface. The Co-ordinating Committee on Marine Science and Technology (now replaced by the Inter Agency Committee on Marine Science and Technology), and the Inter-Agency Committee on Global Environmental Change are two examples of where it has been necessary to create particular co-ordination machinery where many Research Councils and Government Departments are involved. This new machinery has generally performed satisfactorily in ensuring that the necessary contacts are developed, albeit sometimes later rather than sooner. Similar mechanisms may be needed in other rapidly developing interdisciplinary fields with multi-agency involvement.

5.2 It does not, however, in our view remove the need identified in para 1.9 for closer involvement of Research Councils in Departments' in-house advisory bodies. This would help ensure better co-ordination between proposals for new policy initiatives of departments and the underpinning science base in all areas, not just those of an interdisciplinary nature.

6. ARE THERE ANY AREAS WHICH EXPERIENCE PARTICULAR PROBLEMS SUCH AS, FOR EXAMPLE, UK PARTICIPATION IN INTERNATIONAL COLLABORATIVE PROGRAMMES?

6.1 The environment spans national boundaries and much of the research funded by NERC is carried out within an international context. NERC positively encourages scientific collaboration within Europe and worldwide and has encountered no significant difficulties in relation to participation in international collaborative programmes.

6.2 Most international environmental programmes are not dependent on formal subscriptions or long-term commitments to shared facilities agreed at inter-governmental level; thus questions of management and exchange rate problems do not arise. Overall themes are developed by the international scientific community with national research contributions funded on the basis of scientific excellence and national priority. UK environmental scientists are very active in the development and planning of the international environmental science programmes, ensuring the incorporation of UK priorities in these programmes.

6.3 On a national basis, support for targeted research to meet national needs can suffer from uncertainties over where responsibilities lie. Research Councils fund such research themselves where it relates to a high priority scientific need. Government departments also have national need requirements for such research which may or may not equate with the scientific need requirement. Where it does, the departmental requirement may be able to be fulfilled by "licensing in" the scientific output. Where it does not then departments need to be prepared to contract for the required research. Departments are generally good at identifying and funding their short-term applied needs. However, with some exceptions, they are less good at analysing their more strategic long-term research requirements. This is an area which OST and a restructured ACOST could usefully address.

7. WHAT SHOULD BE THE OBJECTIVES OF THE MINISTER AS A MEMBER OF THE COUNCIL OF SCIENCE MINISTERS IN BRUSSELS?

7.1 Strenuous efforts should be made to ensure that EC priorities reflect the UK's priorities for European research and that the EC focuses on those areas where there is clear added value from a European approach or co-ordination. Activities best carried out at a national level or at a broader international level should not be duplicated.

7.2 Efforts should also be made to ensure that EC decisions on funding both of applications under the Framework R&D programme lines and of the Joint Research Centre at Ispra, are based on proper scientific evaluation, with awards made on the basis of scientific excellence.

7.3 Within the UK the Minister should seek to ensure that the UK's success in gaining European research grants does not result in a decline of direct UK government support for R&D.

APPENDIX

DEFINITIONS

Responsive mode — funding of unsolicited research and training proposals from the scientific community, which are unrelated to any special initiatives in defined areas of scientific investigation. This is the normal form of support for individual scientists in the HEIs.

Targeted mode — funding which is tied to special initiatives promoting research and training in defined areas of scientific investigation. This form of support is provided through research grants and training awards to HEIs and is the normal form of support for Research Council institutes and Units. Government Departments also provide targeted funding through their research contracts.

Strategic science — innovative research directed towards practical aims but which has not yet advanced to the stage when specific application can be defined. It may be supported by those supporting the science base (primarily Research Councils), and by Government Departments and occasionally the private sector to meet their own longer term research requirements.

Annex 1

NERC—Its Role

1. The Natural Environment Research Council (NERC) was established in 1965 and is the lead UK agency for research and survey into the natural environment.

2. The NERC Mission is to advance understanding of the natural environment and its resources, the processes and impacts of environmental change at all scales, and to enable better predictions of future change to be made. In fulfilling its mission NERC:
- (i) Supports high quality basic and strategic research in the environmental sciences within its own laboratories and the Higher Education Institutions (HEIs).
- (ii) Undertakes environmental survey and long term observations.
- (iii) Funds postgraduate training.
- (iv) Provides independent expert advice to government and others in the UK and overseas.
- (v) Disseminates the results of its research and surveys.
- (vi) Undertakes work on contract for UK and overseas customers.

3. NERC's remit covers physical, chemical and biological research and survey on the structure and composition of the Earth, the atmosphere, the land surface, the oceans, inland waters and polar regions.

4. Many environmental issues concerned, for example, with climate, the oceans, polar regions, developing countries and pollution transport, have important international dimensions. NERC is a major participant in international environmental science programmes and works closely with partners in Europe and elsewhere.

5. Environmental research requires access to major facilities for the acquisition and processing of data. NERC provides the scientific community with a range of facilities including ocean going research ships, aircraft, computing, equipment pools and analytical services.

6. Data and information are central to the environmental sciences with NERC data holdings forming a valuable national resource. NERC manages a number of computer-based data centres across the different fields of environmental science that provide information and advisory services to a wide range of users in the science community, industry, local and national government, and overseas agencies.

Staffing

7. NERC carries out research and survey activities in its own Institutes and units throughout the UK. A list of NERC Institutes and Units is attached.

8. The number of staff directly employed by NERC in its institutes, units and in HQ in March 1991 was 2,876. Of these 2,309 were staff with open-ended appointments and 567 with fixed-term appointments.

The NERC Budget

9. In 1991-92 NERC total income was £170 million. Of this £123 million was received from the Science Budget and £47 million from contract research carried out for public and private sector customers in the UK and overseas, and from other receipts. Some 28 per cent of the Science Budget income was used in support of research and training in HEIs.

10. The 1991-92 distribution of Science Budget funds between areas of science was Earth sciences (28 per cent), polar sciences (26 per cent), marine and atmospheric sciences (26 per cent) and terrestrial and freshwater sciences (20 per cent).

More Information

11. More information about NERC and the science it supports can obtained from its Annual Reports, Corporate Plan and other documents. Copies of these can be obtained from NERC, Corporate Affairs Unit, Polaris House, North Star Avenue, Swindon SN2 1EU.

Memorandum submitted by the Agricultural and Food Research Council (30 September 1992)

INTRODUCTION

1. The Agricultural and Food Research Council (AFRC) maintains within the UK an internationally competitive research and training base in all sciences underpinning agriculture, food and other industries based on biology and biotechnology. The Council's research and training programmes are carried out in its own network of seven research institutes and by means of research grants, studentships and fellowships in British universities, polytechnics and college (HEIs).

2. The Council and its institutes expect to receieve £164 million in 1992-93. The OST Science Budget is the main source of public funds; the Council's grant for 1992-93 is £110 million. Income for research commissioned by MAFF amounts to a further £34 million. A third component—external income—comprising grants and contracts from industry, trusts, foundations, the European Communities and others, provides a further £20 million.

3. AFRC currently employs 3,600 staff in its own institutes of whom 2,200 are scientists and engineers. Numbers have decreased markedly from 6,300 ten years ago because of financial pressures and restructuring. Within the reduced total much greater use is now made of short-term appointments to match the discontinuous flow of much of the external income and, increasingly, of commissioned research income from MAFF. In addition AFRC supports 900 staff in HEIs of whom 800 are scientists. Taking institutes and HEIs together, AFRC thus supports the work of some 3,000 scientists and engineers throughout the UK.

4. AFRC has developed a highly devolved system of management for its institutes. Within agreed resource management procedures and annual budgets institute directors have extensive delegated authorities, for instance for capital expenditure and for grading and complement control. They are encouraged to seek and retain external research funding. The arrangements allow a small central administration in Swindon to concentrate on strategic scientific and resource planning and on relations with OST, ABRC and the wider world, including other research organisations and industry.

5. In addition to the AFRC network of institutes there are five independent agricultural research institutes in Scotland (SARIs) grant-aided by the Scottish Office. AFRC provides the Scottish Office with strategic advice and quality assessment of the work of the SARIs. The Scottish Office is represented on AFRC Council and senior SARI scientists are appointed to AFRC committees.

OST

6. AFRC warmly welcomes the new Government arrangements for science and technology. They make possible a strategic view of science and technology issues extending beyond the Science Budget. This reflects the reality of the UK science and technology base; it is a continuum of intellectual endeavour and facilities

producing knowledge and technology for society in general as well as for specific industrial sectors and Government departments. OST, reinforced by effective advisory structures, should be in a good position to oversee the totality of Government-funded research, whether funded by departments in support of their policy objectives or by OST through the Science Budget, and to encourage the most effective use of scarce resources.

7. The creation of OST in the Cabinet Office and the changes in ministerial responsibilities mean that science and technology should command more attention at the highest levels in Government. In contrast to previous arrangements, the Science Budget will be the principal spending concern of the responsible Cabinet Minister, the Chancellor of the Duchy of Lancaster. Having a Minister of Cabinet rank representing the UK position on the EC Research Council is also a major step forward.

8. Improving co-ordination in one direction, however, can sometimes create tensions, even gaps, in others. Previously responsibility for both the research councils and the Universities Funding Council (UFC) higher education remit came together in the Department of Education and Science. Under the new arrangements OST and the research councils will have to liaise closely with the Department for Education and the UFC and (after April 1993) the Higher Education funding councils to avoid a mis-match of policies and resources for HEI research and teaching, especially for postgraduate training which spans T and R missions.

Advisory structures

9. Basic and strategic science do not lead directly to specific products and processes. There is no self-regulating model where priorities are set out and driven by a market. Governments have, therefore, to sustain a mechanism to determine priorities between and within broad areas of science for investment of public funds.

10. The broad areas of priority defined by the research councils' activities reflect Government's annual decisions on the balance of priorities at a strategic level. This system can be regarded as a quasi-market where opportunities for new basic and strategic research are considered in the light of the Government's decisions about the merits of each area. On this analogy the OST, the spending department for the £1,000-million-a-year Science Budget, is the customer for the research councils' basic and strategic research. ABRC in this model acts both as market adviser, merit reviewing the work and proposals of the research councils, and as professional adviser to the OST on timely scientific opportunities emerging from the research community.

11. ACOST operates to a much wider remit, providing advice on national priorities and issues beyond basic and strategic research, including departmental research programmes and technology in the private sector. ACOST is therefore the policy adviser to OST, assisting OST in its own co-ordinating and advisory role for departmental research and addressing the fit between the science base and the needs of departmental policy, public good and the private sector.

12. ABRC and ACOST thus have distinctive roles. In any future arrangements it will be important to maintain the functions of policy adviser, market adviser and professional adviser to OST and the Chancellor of the Duchy of Lancaster. These functions require contrasting expertise and approaches and would be beyond the scope of a single council or committee. The "ACOST role" of policy adviser should be provided by a national science council comprising scientists, industrialists, economists and policy makers, including representatives from all Government departments with major research spending. It should be chaired by an industrial scientist but the Chancellor of the Duchy of Lancaster should be encouraged to attend.

13. The present "ABRC role" of market and professional adviser should be carried out by an advisory committee for the Science Budget composed mainly of scientists. Representations of the Higher Education funding councils should attend to provide the important link with HE. The chairman of the advisory committee should be a member ex-officio of the national science council.

14. There will be a continuing need for detailed analyses of particular science and technology issues and policy options to inform the national science council and the advisory committee. These might be undertaken by the Chief Scientific Adviser as part of the normal work of OST.

Research council structures

15. Research councils have a key role in strategic scientific planning, in selectively nurturing areas of promise and in evaluating research. Maintaining the infrastructure, especially facilities, is another important responsibility for research councils. This involves decisions on uneven capital investment which would overwhelm the budgets of individual institutions. More strategically, from time to time it may be necessary to plan and execute major shifts of resource or restructuring leading to closing down redundant or less than fully effective facilities. These strategic elements create the framework necessary for competition between research groups in different institutions; they can only be addressed at a level above individual institutions.

16. The size and shape of individual research councils should be determined, therefore, by the demands of strategic scientific planning and of major capital investment. The evolution of science may require occasional adjustments to the pattern of responsibilities of the research councils. Their constitutional framework should be sufficiently flexible to accommodate future adjustments.

17. For the immediate future research council structures should combine the needs for coherent strategic planning and be of a manageable size. There should also be a rational relationship between mission and the spread of scientific disciplines. The current position displays a certain lack of clarity of mission in the strongly discipline-oriented SERC and an understatement of the contribution to basic science by the mission-oriented councils such as AFRC.

18. The arguments for research councils that are only mission-orientated have weakened as scientific advances have increasingly become generic. Basic research rarely relates to predetermined or expected areas of applied research or application. For example, AFRC research is frequently important to the environment (cycles of greenhouse effect gases) and increasingly bears upon the production of new materials from the land (fibres, designer vegetable oils and novel starches). Moreover, the non-linear model of technology transfer, with interactions between the science base and industry at all points in the basic-applied research continium, militates against a differentiation of research councils on the basis of the basic, strategic or applied character of their work.

19. There is now an opportunity to resolve issues raised in the previous public debate on research council responsibilities, notably the best arrangement for future support of biology. One solution would be to create a biologically-based research council with a mission to further biologically-based industry, including sustainable farming and other land uses, from a strong base of generic biological research. Such a focus would complement and interact with clinical and medical research which should remain with the MRC.

LINKS WITH HIGHER EDUCATION

20. The larger part of the research community supported by the research councils is based in HEIs. OST's strategic perspective of the national science base should include the £700 million to £800 million a year provided by the UFC for research (R funding) as well as the £1,000 million annual Science Budget —the two limbs of the dual support system.

21. AFRC has re-established good links with UFC and anticpates similar good relations with the English, Scottish and Welsh HE funding councils. Information on AFRC research support has been provided to inform the UFC's current research assessment exercise; AFRC-supported scientists are involved as members of some of the panels; and the Council is represented by an assessor on panels with a biological orientation.

22. AFRC sees great merit in adopting a "mixed economy" approach to research support, including "responsive mode" project and programme grants to individuals and "directed mode" support for units and groups in HEIs and other institutions, as well as continuing support for the Council's own seven research institutes. This provides a balance between flexibility and continuity, and between short-term opportunistic research and long-term work requiring a major resource commitment over several years. And it allows AFRC to direct funds to the most dynamic and competitive teams. Maintaining the mixed economy depends on consistent procedures for assessing competing research proposals form the various institutions. Comparable costing is a key factor in achieving a level playing field for assessment.

23. Unfortunately these goals are frustrated by the operation of the dual support system in HEIs. AFRC (and other research councils) have to provide the entire costs of research in institutes, including all overheads, and also are responsible for the physical infrastructure. In HEIs, even after the dual support transfer, the councils meet only the costs of short-term staff, direct recurrent expenses and a contribution to overheads. Permanent staff and accommodation costs are still provided from the UFC's R funding.

24. There is currently no mechanism in HEIs for integrating R funding with research council support to establish the true cost of research projects. This has two undesirable consequences. First, it makes it difficult to match capital investment with concentrations of multi-disciplinary expertise needed fully to exploit scientific opportunities. Secondly, it frustrates moves towards a wider research market whereby HEIs, research council institutes, Government research establishments and executive agencies are all able to seek research council funds on a level playing field.

25. The dual support transfer has helped movement towards a fuller costing of HEI research, but it is worth considering whether further change is needed. A radical approach would be to transfer the entire R funding to the research councils. But this would create a new family of problems and tensions, not least in HEIs who have quite correctly invested past R funding in physical infrastructure and permanent appointments. What is needed is a procedure to identify with greater precision than at present how research funding in universities relates to research council support of research. This would achieve full costing, a level playing field, an optimal infrastructure and greater accountability.

PARTICIPATION IN INTERNATIONAL COLLABORATIVE PROGRAMMES

26. Within Europe AFRC participates in the planning and execution of research programmes under the EC R&D Framework Programmes and in the networks and programmes of the European Science Foundation (ESF). Individual collaborations between scientists are also facilitated by bilateral agreements with AFRC's counterparts in some EC member states and more widely in the rest of Europe and in other developed countries, notably Japan, Australia and New Zealand. AFRC is also actively pursuing closer contact with ODA, the British Council and multilateral agencies concerned with the development needs of developing countries. Mechanisms may be needed to improve the integration of the UK science base with aid-related technology and development programmes.

27. Participation in EC programmes is not without its difficulties. A major concern is the EuroPES system whereby the costs of EC programmes are attributed to UK Government departments. Agreement to larger EC programmes in basic science can lead to a reduced Science Budget and less support for domestic programmes to which research councils might attach higher priority. Of course UK research teams win back EC project funds, but this is not necessarily for research judged to be of high priority by research councils. And there is no guarantee of continuity, with consequent adverse effects on scientists' careers. This is an unsatisfactory use of Science Budget funds. Under earlier arrangements the Science Budget was not committed to payments from which the UK could not withdraw on scientific grounds, i.e., on the basis of scientific assessment.

EC COUNCIL OF RESEARCH MINISTERS

28. The new arrangements for science and technology mean that a Minister of Cabinet rank, the Chancellor of the Duchy of Lancaster, will represent UK interests on the Research Council. AFRC greatly welcomes this move which should increase the UK's influence on S&T issues within the Community. AFRC's experience of the Commission's planning, assessment and management of research programmes indicates that the Chancellor should aim to improve the efficiency and effectiveness of these procedures by:

- Ensuring that proposed EC programmes add value over what can be done nationally. In scientific areas relating to AFRC, community action will generally meet the subsidiarity criterion only in terms of critical mass or networking. There is thus a need to try to define where networking would particularly justify the investment of EC funds; the development of generic technologies would be one important area.
- Pressing for scientists (from all member states) to be more fully involved in the *formulation* of new programmes, rather than just drawing them into evaluation exercises.
- Seeking to increase the effectiveness of the Commission's evaluation procedures by setting clear objectives at the outset of programmes.
- Pressing for the focus of individual research programmes to be sharpened and appraisal procedures to be improved. This should decrease the present unacceptably large number of disappointed applicants, many of whom feel they have wasted their time submitting detailed proposals.

Memorandum submitted by the Medical Research Council (7 October 1992)

1. *The Medical Research Council*

A brief description of the MRC is attached at *annex 1.*

2. *Advisory structure on science and technology*

The Council welcomes the creation of the Office of Science and Technology and the appointment of a Cabinet Minister for Science. These steps—and the intention to publish a white paper—are acknowledgments of the need for explicit policies and strategies for what scientific research should be carried out and how it should be related to national interests.

Developing and carrying through a national strategy for research cannot be left to natural processes in HEIs, since these institutions will and should be dominated by educational issues and educational reform, at least for the next decade. Nor can it be expected to emerge from the totality or research activities of Government Departments, since these are necessarily and rightly focused on the short- and medium-term priorities that separately need to be addressed.

The national interest therefore requires a Research Council structure that is managed within a framework of strategic planning under the Office of Science and Technology. The Research Councils should integrate the various scientific needs within and across Government Departments and develop coherent research programmes to address those needs, so achieving the economies and benefits of scale. To do this they must build on a platform of relevant high quality exploratory research which expresses the best and most imaginative forward directions of the UK's scientific community.

Given this approach the national strategy could be formulated in terms of a number of research missions. The Research Council structure should be organised in line with those missions. Research Councils must continue to be free to pursue an independent policy in deciding both scientific strategy and what research should be funded; the short-term needs of Government should influence but not determine what research is carried out. Research Councils would be held accountable for their performance against their mission statements.

Given the Government decision to develop a strategy for science and technology, we would favour setting up a single Science and Technology Co-ordinating and Advisory Board chaired by the Chancellor and with a strong and effective secretariat. The Board would be concerned with the strategic issues of the overall pattern and balance of scientific activity in the UK and relationships with international programmes; with the institutional and manpower infrastructure; and with harmonising and improving the overall planning and management of research in the public sector and its interactions with the private sector. Members would include the Heads of the Research Councils (as "Executive Directors", those responsible for directing the OST's own instruments for planning and managing research and training) and independents drawn from a range of disciplines and from those concerned with implementation (e.g., industry).

The Board might be advised by three sub-committees:

(i) One modelled on ABRC to assess and advise on Research Council performance. The Chairman of such a Sub-committee might then be a valuable source of independent advice to OST on the Research Councils;

(ii) One modelled on the Science and Technology Advisory Group bringing together Departmental Chief Scientists and the Research Councils. (Since the line management of Departmental Chief Scientists is, by definition through other Government Departments, they would not be members of the Board itself.)

(iii) A similar sub-committee might focus on relations with HEIs and with DFE.

The Board would also need to set up *ad hoc* groups to undertake ACOST-style, think tank studies when needed. Such groups might also serve as a way of testing out those who might in due course serve on the main Board.

The proposed structure is set out in diagrammatic form in *annex 2.*

3. *Co-ordination in funding policy*

The UFC's current research assessment exercise has been informed by data on Research Council funding. Moreover, MRC assessors serve on the advisory panels in relevant subject areas. In broad terms there is therefore co-ordination between the UFC and the Research Councils in terms of funding policy.

Our current concerns focus rather more on how the research component of HEI funding is used once allocated. We are anxious to ensure that HEI investment in research infrastructure maps on to MRC investment in grant and unit support and in Interdisciplinary Research Centres. The Council's relationships with HEIs have therefore become more interactive in recent years and we have been developing closer contacts with individual institutions. The aim is to try and develop joint research strategies where these are of mutual benefit. The approach that we have adopted over the development of our Clinical Research Initiative, which involves building up a number of centres where interdisciplinary research groups can work in clinical evironments, provides a good example of the way interactions with HEIs will need to evolve.

4. *Role of ACOST*

As will be clear from section 2 above, in our view the Government decision to develop a stategy for science and technology necessitates a fundamental rethinking of the role of ACOST and we are proposing a rather different advisory structure. Provision must continue to be made for undertaking ACOST's think-tank role but this could be handled by *ad hoc* groups set up by the main Co-ordinating and Advisory Board.

5. *Problems associated with the way science policy was previously co-ordinated*

In September 1990 the Council submitted evidence to the House of Lords Science and Technology Committee: Sub-committee II on international scientific programmes. In that submission we said:

> "For politically driven 'top-down' initiatives negotiation with participating countries is often conducted by the Cabinet Office, with advice from the relevant Departments. The MRC may be invited to provide input via the DES and possible DH. This flow of information may satisfy the political objectives of the exercise. However, it can also serve to inhibit the extraction of maximum scientific benefit from the collaboration. This is because the input from the scientific community is

> too remote from the ultimate decision-making point in the process of planning and implementation of new ventures. in the interests of greater cohesion of national scientific priorities the MRC would like to see stronger strategic scientific input to the establishment and running of international scientific programmes, perhaps through the mechanisms of an interagency committee, to ensure that the UK approach to such ventures is set within a true framework of national scientific priorities. A good example of where such a development might work to the advantage of the UK would be in negotiations over the EC Framework Programme where, despite a developing consultation network, there still remains a fundamental lack of strategic scientific direction."

The establishment of the OST and appointment of a Cabinet Office with responsibility for science should in fact resolve the Council's concerns more effectively than the interagency committee suggested in the extract above.

6. *International collaborative programmes*

6.1 *Background*

The Council's policy is to participate in international activities which contribute to the development and implementation of the Council's scientific policies and to assist in developing for the benefit of the UK biomedical community scientific opportunities which cannot be provided within the UK.

The MRC is responsible for payment of the UK subscriptions to (i) the European Molecular Biology Laboratory and the European Molecular Biology Conference (total subscriptions: £3,453k in 1991-92); (ii) to the WHO International Agency for Research on Cancer (£571k in 1991-92); and (iii) to the Human Frontier Science Program (£350k in 1992-93); and for providing UK representation on the appropriate governing bodies of these organisations. The MRC, on behalf of the OST and in conjunction with the Department of Health, also takes the lead for the UK on the EC Biomedical & Health Research Program.

The MRC is an active member of the European Science Foundation (ESF) and the European Medical Research Councils (a Standing Committee of the ESF), of which the Secretary of Council is currently Chairman.

MRC scientists participate in a range of EC and other international programmes including those of WHO, Human Frontier Science Program and NATO. In addition to these formal collaborations Council scientists work together on an informal basis with scientists throughout the world and in many instances these collaborations form the basis for more formal links.

6.2 *MRC priorities*

We regard the following as essential components of successful participation of international programmes:

(i) *Scientific quality:* To ensure value for money and the credibility of the individual research programme or project scientific quality must be established as the principal criterion regardless of any other objectives of the programme. Adequate assessment and evaluation processes must be established to ensure selection of projects meeting international standards through the peer review process, followed by thorough and timely *post hoc* evaluation of the project and programme.

(ii) *Added value:* The added value of participation in international projects or programmes must be clearly identifiable if the use of UK research funding is to be justified. We do not support the use of Science Vote funds for funding research which could be carried out as well or better nationally without European or international partners.

(iii) *Accountability:* Where the UK is contributing financially to an international programme or project it is essential that there are mechanisms in place which allow for financial and managerial accountability.

(iv) *Co-ordination with national priorities:* Similarly there must be adequate national representation on the governing structures of the programme to ensure co-ordination with national activities and priorities.

6.3 *Problems*

(i) Problems can arise where particular programmes are politically driven without proper regard to questions of scientific quality and added value. For example, the stated aim of cohesion which pervades the EC Framework Programme can influence the content of programmes, the allocation of funds and the quality of science supported in direction contrary to the UK's interests.

(ii) Assessment and evaluation procedures do not always match up to the UK's normal standards, resulting in the support of inferior science and lack of Programme credibility.

(iii) Budget increases sought by international programmes may well conflict with national priorities and are outside the UK's control. For example, the United Kingdom's contribution to the

European Molecular Biology Laboratory increased by 76.8 per cent over the decade 1983 to 1992 compared with an increase of 68 per cent in OECD European consumer prices over the same period. Had the funding of those contributions been in direct competition with other claims on the Council's funds it is unlikely that such real growth would have been sustained. There are the additional problems caused by a fluctuating exchange rate.

7. *Objectives of the Minister as a member of the Council of Science Ministers in Brussels*

The priorities set out in 6.2 above are of general application to EC programmes and are principles that should be pressed in the Council of Science Ministers.

In addition there is a role to play in promoting international research programmes where they offer real benefit. Examples in the medical research area are:

Epidemiology—research involving the multicultural multiethnic community of Europe, such as studies on the interactions of genetic and environmental factors on health.
Health services research—research exploiting differences in health care systems, or identifying the most effective methods of health care delivery.
Multi-disciplinary teams, where skills are in short supply.
Multicentre trials and studies, such as longitudinal studies on ageing in different cultural settings, studies of rare disorders, evaluation of expensive technologies.
Training—to exploit the unique strengths of individual countries.

(These are approaches identified as leading to added value by the Programme Advisory Committee of the EC Biomedical and Health Research Programme with support from the MRC).

In addition international programmes can provide a co-ordinating mechanism in specific areas, for example where there is a risk of duplication of work, (e.g., the EC AIDS programme), where there is need for an international initiative, (e.g., the EC human genome analysis programme), or where a sharing of common interests will lead to a co-ordinated approach to a particular problem, (e.g., initiatives of the European Science Foundation and European Medical Research Councils).

ANNEX 1

The Medical Research Council

1. The Council's aim is to promote research which has as its ultimate objective the maintenance and improvement of human health. Within a single organisation it integrates research of direct relevance to clinical practice and to health service provision with basic biological research. This ensures that a broad spectrum of basic research is supported with a view to its potential medical relevance, a key factor in speeding up the process of applying scientific advances to clinical practice and to health care provision.

2. The Council's total income in 1992-93 is approximately £253 million. Of this £228 million is received in the form of a grant in aid from the Science Budget. The remaining £25 million covers receipts from industry and charities, income from Government Departments, sales of land and buildings and use of the MRC's own private funds.

3. The Council maintains a range of forms of support to meet the needs of different research fields and research programmes and to provide differing research environments.

4. The Council employs about 4,000 staff in three research institutes (National Institute for Medical Research, Laboratory of Molecular Biology and Clinical Research Centre) and 45 research units. Forty of these 45 units are embedded in Higher Education Institutions (HEIs). Over the course of the past 10 years the Council has opened 12 units and closed 23.

5. In addition the Council supports some 2,800 scientists and technicians through programme (five year) and project (three year) grants to researchers in HEIs.

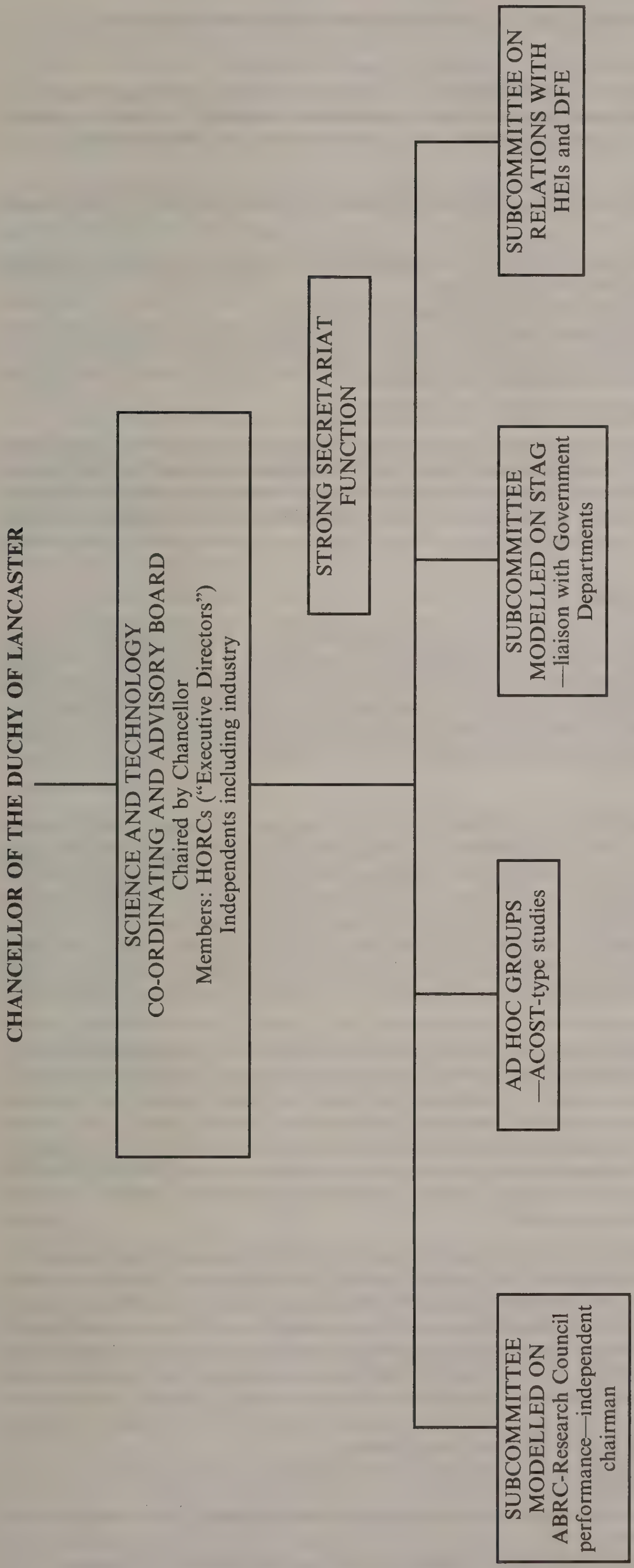
6. The Council makes a major contribution to the training of medical research workers at the postgraduate level and above. Some 1,200 scientists are enrolled in research training schemes at any one time.

7. The Council has established a number of initiatives in areas of high scientific priority and/or national importance, e.g., AIDS, Human Genome Mapping Project, Clinical Research Initiative, Genetic Approach to Human Health and the Neuroscience Approach to Human Health. The Council has adopted a variety of different funding policies and management strategies tailored to meet the needs of the scientific field concerned. In all cases initiatives make use of traditional mechanisms of MRC support (institutes and units, grants, training schemes).

8. The Council places a high priority on technology transfer both to the NHS and to industry.

9. In implementing its research plans the Council collaborates with a range of other organisations: Government Departments, the NHS, other Research Councils, industry, charities, international bodies. Collaboration takes a wide variety of forms: joint initiatives and funding arrangements (especially in relation to capital projects and long-term ventures), exchange of information on policies and priorities, cross-representation on funding bodies. Particularly close relations are maintained with the Council's main "Customer Departments": the Health Departments (collaborative arrangements are enshrined in the form of a Concordat agreed at the beginning of 1992) and the ODA.

ANNEX 2


CHANCELLOR OF THE DUCHY OF LANCASTER
SCIENCE AND TECHNOLOGY CO-ORDINATING AND ADVISORY BOARD Chaired by Chancellor Members: HORCs ("Executive Directors") Independents including industry
STRONG SECRETARIAT FUNCTION
SUBCOMMITTEE MODELLED ON ABRC-Research Council performance—independent chairman
AD HOC GROUPS —ACOST-type studies
SUBCOMMITTEE MODELLED ON STAG —liaison with Government Departments
SUBCOMMITTEE ON RELATIONS WITH HEIs and DFE

Memorandum submitted by the Economic and Social Research Council (26 October 1992)

THE WORK OF THE COUNCIL

1. The Economic and Social Research Council (ERSC) is responsible for public funding of basic and strategic social science. Our field embraces the disciplines of economics, economic and social history, education, psychology, geography, management, political science, international relations, sociology, social anthropology and others.

2. Our budget in 1991-92 was £38 million, mostly from the Science Vote. We employ 110 staff at our headquarters in Swindon.

3. In our 1992 Corporate Plan we restated its mission "to increase understanding of social and economic change." In pursuit of that we adopted five long-term aims:

- To support research which expands and communicates knowledge.
- To increase the number and enhance the skills of social scientists.
- To innovate data resources, research methods and technology.
- To help research institutions improve their performance.
- To improve the economy and effectiveness of Council operations.

4. ESRC pursues its mission and long-term aims through its programmes for research, training and research resources. These programmes are undertaken principally in universities (including the former polytechnics) and some independent research institutions. Unlike the other research councils we have no research institutes or facilities of our own. The management and development of these programmes is the business of Council's Boards within a framework of policy decided by Council and expressed in its annual Corporate Plan.

THE OFFICE OF SCIENCE AND TECHNOLOGY

5. We have already welcomed the creation of the Office of Science and Technology. It must be the prime purpose of OST to provide strategic direction to the expansion and exploitation of knowledge through scientific research. In our view that strategic direction has been too weak in the past. We do not argue that science policy should be just left to scientists; but nor is it a matter just for politicians and officials. It is extremely important that OST draws systematically and openly on advice from research customers, providers and purchasers in determining the strategic direction for UK science.

ACOST AND ABRC

6. We recommend that OST should have two advisory bodies. A revamped Advisory Committee on Science and Technology (ACOST) should be composed of both scientific and lay persons who are independent of both the research councils and the government departments. Its members should be conversant with all kinds of science, including social science. Its role should be to advise the Minister on the broad balance of funding between different kinds of science (including civil/defence, government/business, research councils/government departments, basic/strategic applied), to identify new areas of national scientific priority, and to examine issues of scientific capacity. It should conduct most of its work through Task Forces which would draw membership from *inter alia* the research councils and government departments.

7. This body should not assume the ABRC's present responsibility for advising on research council's annual Corporate Plans and Forward Look bids on Science Vote expenditure. But we consider it important to retain arrangements for assessing annually the programme proposals for public funding of basic and strategic research prepared by research councils; but such arrangements should extend also to the programme proposals of government departments. Such arrangements for joint consideration of research council and government department proposals should be designed to encourage and reward collaboration between them, and with business. Such collaboration should be particulary focused on fields of strategic research as a major stimulus to knowledge transfer.

8. We judge that it would be scientifically and politically desirable for this assessment of proposals to be undertaken, and seen to be undertaken, by a body at arm's length from Ministers. This body would replace the present Advisory Board for the Research Councils (ABRC). Since its focus would be on public support of the science base the body should be representative of the universities, the research councils and government departments as the principal purchasers and providers of science base research; but there should also be representation of research customers. Such a body would provide a source of independent advice to Ministers on the merit of funding proposals which they should consider alongside the policy advice from the new ACOST. Final decisions would then be for Ministers to take and for OST officials to execute through the separate research councils and government departments.

LINKS WITH HIGHER EDUCATION INSTITUTIONS (HEIs)

9. Major changes in the funding of research in HEIs are currently taking place. These consist, in no particular order, of:

(i) The transfer of funds from the Universities Funding Council to the Research Councils.

(ii) The UFC's Research Selectivity Exercise.
(iii) The abolition of the binary line.
(iv) The creation of Higher Education Funding Councils for England, Scotland and Wales (with arrangements in hand to establish a similar body in Northern Ireland).
(v) Rising staff/student ratios consequent upon the desire to create a higher participation rate in higher education.

10. It is by no means clear how the HEI system will emerge from these changes, whether they are viewed separately or, more appropriately, in combination. It is already clear, however, that research will be funded more selectively in the HEIs and that the quality of institutional management will be critical in ensuring that these resources are used most effectively. The Research Councils clearly have an interest in continuing to develop a high quality research base in the HEIs. However, universities rightly guard their own academic autonomy and will, understandably, resist any attempts to take what might be interpreted as interference in their internal management affairs. It is clear, therefore, that the Research Councils will need to redefine their relationships with the HEIs so that, within a competitive system of quality control, partnerships may develop which ensure that the highest quality research continues to be supported.

11. This, in turn, requires a robust system of co-ordination with the new Higher Education Funding Councils. It seems likely that their policies over the funding of research will be, to some extent, divergent, in order to take account of regional exigencies. This will reinforce the need for co-ordination with the Research Councils. How this will be achieved remains to be seen. There are already one or two disturbing signs that fragmentation could result.

International collaboration

12. In recent years social science has become increasingly international, particularly European. Many of the changes which social scientists research can only be understood in an international context, particularly through the shrinkage of space by transport and telecommunication and the globalisation of politics and business—[10 per cent] of the applications to our research grants scheme now have an international dimension. And researchers increasingly want to address such issues by internationally collaborative work. Notwithstanding the argument above for a strong UK social science researching UK society, we believe that this internationalisation is to be encouraged. We hope that an Office of Science and Technology will be better able to represent UK science—including social science—internationally and help to foster collaboration.

13. The European Community is an increasingly important influence on UK science. To date its commitment to social science has been principally either in the applied research or consultancy commissioned by policy Directorate Generals or in some technology assessment aspects of the natural science it supports under the Framework Programmes. UK social scientists have been very successful in securing these funds. But we are convinced that there is a compelling case for the Community to move beyond this and recognise—particularly in the context of the Maastricht Treaty and the redefinitions of Community competence—that it is unsupportable for it to develop European policies for agriculture, competitiveness, security, finance and so on without funding good basic and strategic science to provide the necessary understanding of contemporary social and economic change in Europe. The collation of national social science is an inadequate substitute. We therefore greatly welcome the proposal of the UK government for a separate social science component in the Community's Framework Programme 4.

ANNEX

ESRC Programmes

Research

1. The ESRC's role as the UK's leading funder of basic and strategic research in the social sciences is an essential element in its corporate strategy. Our research funding contributes to development of the social science base through the expansion of knowledge; it also enables social scientists to enhance their skills, develop data resources and methods and apply technology, and thus provides institutions with a range of opportunities to improve research performance. The Council offers four modes of research support—research centres, research programmes, research grants and research seminars.

Training

2. The training of social scientists is a key contribution to the development of social science. The quality of research results, their contribution to informed decision-making and the reputation of social science all rest on attracting able graduates into social science research and nurturing the professional skills they need for successful careers. With the Council's commitment to developing the social science base, the training of social scientists as academic researchers and teachers must be its prime responsibility. But trained social

scientists work in many fields. Business is a major employer—in management, marketing, personnel, planning and management consultancy. The many branches of government also require social scientists as researchers and research managers. ESRC's training programme supports postgraduate students, mid-career training and career moves between practice and research.

Research resources

3. Research resources-data, research methods, information technology and institutional provision—are needed whether social science research is qualitative or quantitative in approach, whether it is interdisciplinary, multi-disciplinary or within a single discipline, and whether conducted by a single researcher or a research team. Whereas in other areas of research the ESRC is one among many UK funders of social science, those other funders—government, business, charities, the EC—are reluctant to devote funds to developing such research resources. Much of the development and availability of these resources depends therefore on the support of the ESRC. While willing to take the lead, the Council seek to engage both business and government in collaborative work on research resources. They are both major sources of data and major beneficiaries of developments in research resources.

Science and Engineering Research Council (30 October 1992)

1. Introduction

1.1 The Science and Engineering Research Council (SERC) is responsible for support of basic sciences and engineering aimed at:

(a) Maintaining the nation's capabilities in fundamental research;

(b) Developing capabilities in strategic areas likely to be of long-term benefit to wealth creation and improving the quality of life.

SERC fulfils this role through funding of research in Higher Education Institutions (HEIs); providing support for postgraduate and postdoctoral education and training; provision, in its own laboratories, of first class research facilities, for use by academic researchers; and providing access to facilities run by international institutions.

1.2 A brief description of SERC organisation and activities is given in the document "What is SERC" attached at Annex 1. A more detailed description of the SERC programme for the years 1993-94—1995-96 is given in Annex 2. This includes details of funding (overall summary on p.3, and details throughout the text) and staffing (para 89, p.21).

1.3 A brief response to the questions posed by the Select Committee is given below. Further amplification can be provided if required.

2. Q1: What structure does the government need to advise it on science policy?

2.1 The advisory structures set up by Government should deal not only with science policy but also technology policy.

2.2 There should be a single, top level, advisory body with overall responsibility for providing advice on all Government funded R&D activity (currently including Research Councils, Funding Councils, and Government Departments). This body would be responsible for providing a balanced view of all scientific and technological endeavour and to give advice on a strategic level. It should concentrate on aspects where an overview of Departments', Research Councils' and Funding Councils' plans allows overlaps, economies and imbalances to be detected. Whilst there is an argument for this body to report to the Chancellor of the Duchy of Lancaster, in his capacity in co-ordinating science and technology policy (through OST), we consider that in practice, this body will only have sufficient influence over all Departmental spending plans if it is independent of spending Departments, and should therefore report to the Prime Minister.

2.3 Each Spending Department should be free to establish its own mechanisms for allocating the research monies within its control. As is evidenced by practice in some Departments, there is not a pre-requisite for an Advisory Committee at this level. Irrespective of specific arrangements established within Departments, these should not compromise the accountability and reporting lines of the Permanent Secretary and Chief Executive or Chairman of any subsidiary body: there should be a clear separation of executive and advisory roles.

3. Q2: Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate?

3.1 A reconstituted ACOST could fulfil the role of the top level Advisory body, but needs to have full oversight of *all* government funded activities (Research Councils, Departments, and Funding Councils) and the accepted authority to recommend changes in balance and type of support. Specific arrangements for allocating resources within Departments should be left to the Department concerned in the light of the advice. There is no automatic need for a body like ABRC to assist OST in allocating funds to Research Councils. If OST decide that an Advisory Committee is required, its role should clearly focus on scientific strategies and funding balance, rather than on management and monitoring of performance. The latter should be left to OST and the Accounting Officer line.

4. Q3: IS THERE A NEED FOR BETTER CO-ORDINATION IN FUNDING POLICY FOR HIGHER EDUCATION INSTITUTIONS BETWEEN THE RESEARCH COUNCILS AND THE FUNDING COUNCILS? IF SO, HOW IS THIS TO BE ACHIEVED?

4.1 Whilst the relationship and co-ordination between the Research Councils and the Funding Councils has recently improved considerably, this relationship is fragile. The reorganisation of the HEI funding system into regional Funding Councils raises the possibility of future divergence of policy both between the Funding Councils themselves, and between the Funding Councils and the Research Councils.

4.2 It is critically important that HEFCs policies reinforce the strength of the HEI base in those areas of science and technology seen as key to wealth creation, quality of life and intellectual progress. There therefore needs to be strong co-ordination between the HEFC, as provider of the funding which maintains the strength of this resource base, and *all* funding bodies including Research Councils, Government Departments, Industry and others, who are customers for the HEI base.

4.3 Effective co-ordination of HEFC spend with that of other funding bodies will require greater accountability for use of HEFC research funds by HEIs. If this cannot be achieved through HEFC, there is a strong argument for transfer of responsibility for relevant parts of HEFC research spending to appropriate Research Councils and Government Departments. This would also help cohesiveness of approach, and improved ability to judge value for money. Basically, however, we should aim to retain the HEFC funds with the universities. The establishment of a Humanities Research Council, which is highly desirable could lead to an additional DS transfer to the Research Councils on that account.

4.4 The top level Advisory Body should take prime responsibility for ensuring co-ordination and cohesiveness of approach between HEFC and other Government funding bodies.

5. Q4: WHAT SHOULD BE THE FUTURE ROLE OF ACOST AND IS IT APPROPRIATE FOR THE EFFECTIVE CHAIRMAN TO CONTINUE TO BE AN INDUSTRIALIST WITH A TECHNOLOGICAL BACKGROUND, OR SHOULD THE MINISTER TAKE THE LEAD?

5.1 See answer to Questions 1 and 2. In order to separate ACOST's advisory role from OST's executive role, and to avoid the possibility of confusion on policy, (e.g., when the Minister chooses not to follow the advice of his own Advisory Committee), we believe that, on balance, the Chairman should continue to be an independent.

5.2 The reconstituted ACOST should consider all issues of science and technology policy—not only policy with regard to wealth creation but also that related to quality of life, intellectual advance, and maintenance of the science and technology resource base. There is no particular reason for the Chairman to be an industrialist: what is required is an effective and respected person, with a broad knowledge of science and technology.

6. Q5: CAN ANY PROBLEMS WHICH AROSE FROM THE PREVIOUS WAYS IN WHICH SCIENCE POLICY WAS CO-ORDINATED BE IDENTIFIED?

6.1 SERC does not consider there was really any effective cross governmental co-ordination of science (and technology) policy. Whilst too much top down direction should be avoided (the practice of "picking winners" is fraught with problems)—there does need to be co-ordination of Departmental, Research Council and Funding Council plans to ensure the best value for money in Government spending, together with an overall broad framework of objectives.

7. Q6: ARE THERE ANY AREAS WHICH EXPERIENCE PARTICULAR PROBLEMS SUCH AS, FOR EXAMPLE, UK PARTICIPATION IN INTERNATIONAL COLLABORATIVE PROGRAMMES?

7.1 The way in which the UK manages and pays for its international science is unsatisfactory. Basically if the *Government* enters internationally binding agreements, or if an agency does so on its behalf, then the Government should meet those incurred costs which result from costs of inflation and/or exchange rate changes where these differ from than the planning assumptions and/or inflation "uplift" factors set by Treasury. The SERC would not welcome the full transfer of responsibility for international programmes to the FCO: these programmes do need proper integration with science policy. However, the overall science base does need a degree of protection from excessive external pertubations outside its control.

7.2 The SERC consider that there are particular problems with regard to funding of science and technology by the EC. Whilst the value of European collaboration organised through the EC cannot be dismissed, it should be based more strongly on the principle of "subsidiarity", i.e., international collaboration should only be encouraged when it confers benefits over and above those to be gained by parallel individual efforts of EC States. The current contents of the Framework programmes do not appear to properly reflect the subsidiarity principle, nor does individual project selection conform with this principle.

7.3 Unless EC policies are such that UK science and technology funds are spent on the highest quality groups or in areas of the highest strategic importance to the UK, the reduction, through EuroPES, of the science vote to account for EC funds, is a matter of serious concern.

8. Q7: WHAT SHOULD THEN BE THE OBJECTIVES OF THE MINISTER AS A MEMBER OF THE COUNCIL OF SCIENCE MINISTERS IN BRUSSELS?

8.1 The Minister should focus attention on improving the effectiveness and added-value of EC operations. The long-term objective should be to ensure that EC programmes properly reflect scientific needs in the light of the principle of subsidiarity: both in content choice and of projects to be supported. The Minister should press for improved appraisal and evaluation mechanisms, including more extensive use of informed and unbiased peer and merit review, and more extensive and open consultation with the scientific and industrial communities.

Memorandum submitted by the Chief Executive of the Higher Education Funding Council for England (4 November 1992)

1. CONTEXT

A formal submission will be made by the Higher Education Funding Council for England (HEFCE) relating to the White Paper being prepared by the Office of Science and Technology (OST) after the Council meeting on 24 November. This brief statement embraces some central issues on which recommendations will be made to the Council and which are consistent with the Council's policies to date.

2. BACKGROUND

Institutions of Higher Education (HEIs) are collectively the major national providers of research across all fields of science and technology. The research they undertake covers a very wide spectrum; it includes basic research into fundamental new areas of knowledge, strategic research aimed at focusing the outcomes of basic research onto particular problems or areas of interest, and mission-oriented work, which is often contract-based, aimed at a particular customer or application.

This work is undertaken by a combination of full-time research staff, others who carry out both teaching and research, and by research students who work closely with their academic supervisors or with industrial and commercial sponsors while studying for a research degree. This highlights the importance of HEIs as producers of highly qualified manpower, whose advanced training and research expertise meets the needs of many sectors of the economy and helps promote the UK's international competitiveness.

Funding for carrying out this research and providing research training is received by HEIs from a range of sources. Grant provided by the Funding Councils is usually the largest single element, but it does not account for the majority of income (see attached Annex). The external research income gained by universities amounted to £857 million in 1990-91 (the most recent year for which full data are available). External research income has grown in real terms by c.13 per cent per annum in real terms in recent years (see attached Annex).

3. THE DUEL FUNDING PRINCIPLE

The HEFCE will inherit from the Universities Funding Council, and its predecessor the University Grants Committee, the responsibility for maintaining one side of the "dual support" system, a system which the Council is committed to maintain. Under the dual support arrangements. Funding Council funding provides for the costs of the basic infrastructure of university research.

4. THE PURPOSE OF THE COUNCIL'S RESEARCH FUNDING

Within the above overall picture, the research-related allocation provided by the HEFCE has a number of principal purposes:

- It covers almost all the costs of the basic research undertaken by HEIs, which forms the foundation for strategic and applied work, much of which is supported by other Government funds and by charities and industrial and commercial organisations.
- Under the dual support system, it covers a proportion of the costs associated with projects otherwise funded by the Research Councils; the new arrangements for dual support introduced following the 1991 White Paper mean that HEFCE funds will provide for the costs of permanent academic staff and premises required for such projects.
- It contributes to the some of the infrastructure costs of training research students.

- It provides the stability of funding for research which enables HEIs to establish the long term strategies essential for the attainment of excellence.
- It allows for the identification and pursuit of new areas of research in advance of their support from Research Councils and other funding sources.
- It provides resources which allow for the support of new and young entrants to the academic community while they are establishing their research credentials.

5. THE COUNCIL'S OBJECTIVES

In allocating resources to institutions the Council applies a number of broad principles, which have been developed taking account of Government policies, and extensive consultation both within the HE sector and more widely. These are:

Plurality: the Council's allocations build on the advantages which the availability of a range of funding sources brings, and seek to complement but not duplicate the aims of other funding agencies.

Selectivity: the Council allocates funding selectively, according to the quality of research carried out in each HEI. Quality is assessed through triennial research assessment exercises which produce ratings which are independent of those of other funding agencies and which are the only systematic and comprehensive assessment of the overall research output of each department in the HEIs.

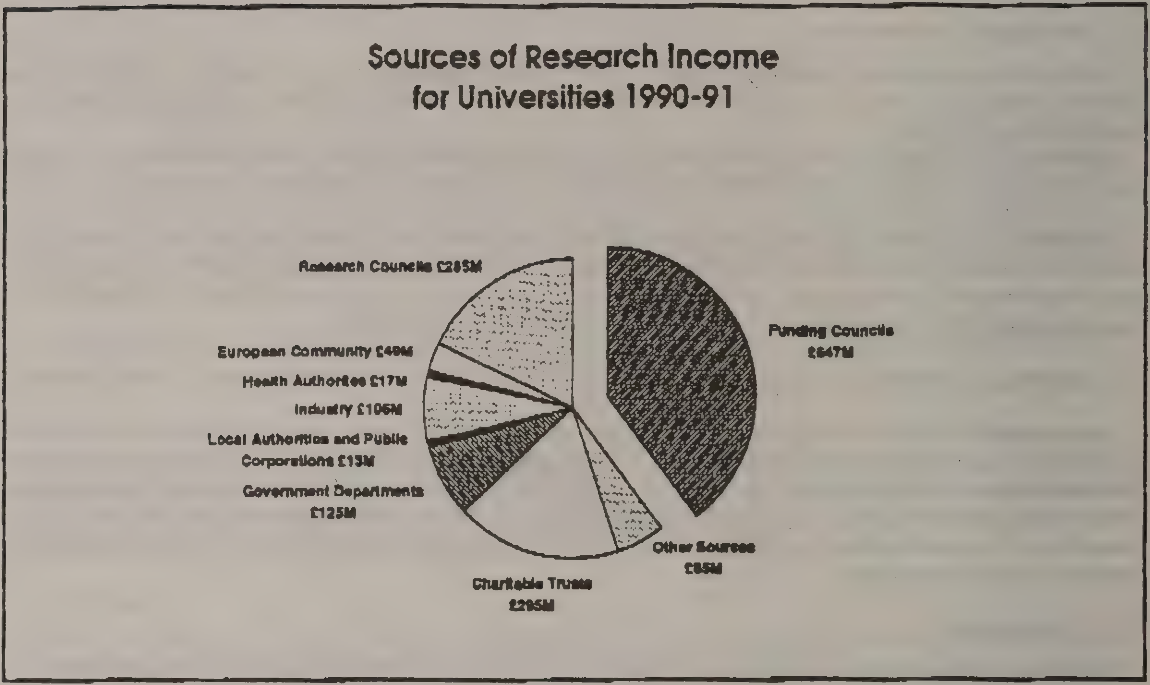
Competition: all eligible institutions should be able to compete for the resources at the Council's disposal.

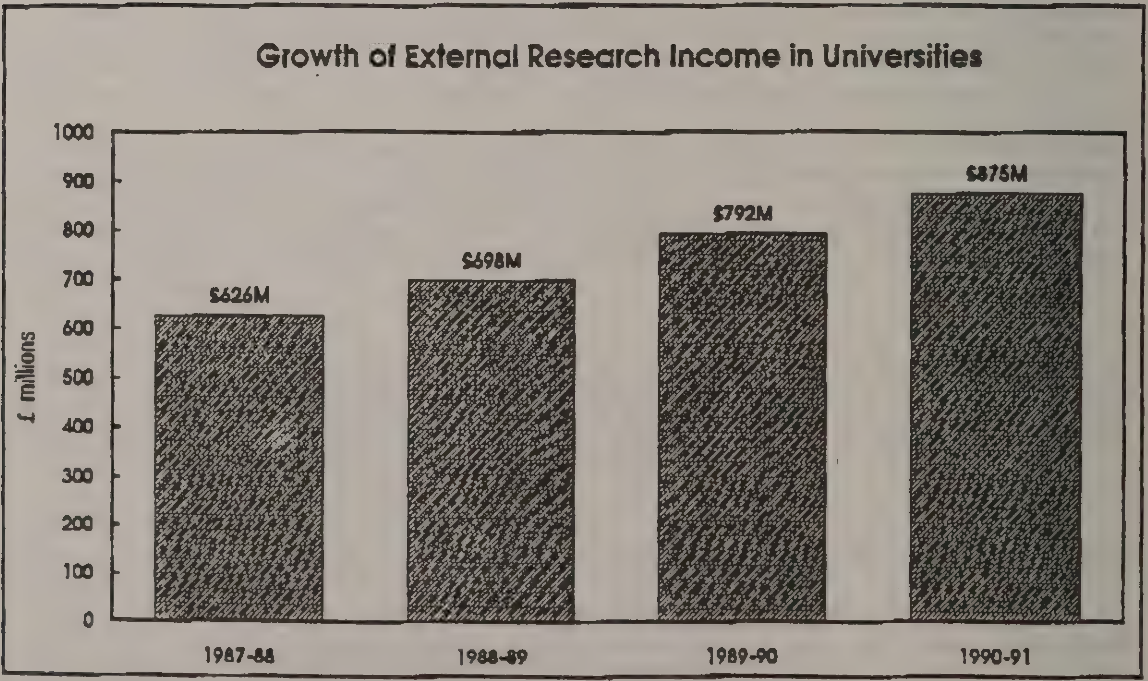
Accountability: funds for research are not earmarked to particular projects or subject areas, and bearing in mind that the Council is almost the only source of general unearmarked research funding available, it believes that institutions are in the best position to determine the direction of the basic and strategic research which these funds support. The Council is now developing improved methods through an external consultancy to achieve clearer accountability, which will involve statements of the use to which funds have been put and the outcomes.

6. OTHER ISSUES

The Council endorses the importance of technology transfer and ensuring the translation of basic research into strategic and applied work.

ANNEX


Sources of Research Income for Universities 1990-91


Growth of External Research Income in Universities

Examination of Witnesses

PROFESSOR THOMAS BLUNDELL, FRS, Director General of the Agricultural and Food Research Council, PROFESSOR GRAEME DAVIES, F Eng, Chief Executive of the Higher Education Funding Council for England, PROFESSOR JOHN KNILL, F Eng, Chairman of the Natural Environment Research Council, DR ANTONY HUGHES, Director, Programmes and Deputy Chairman of the Science and Engineering Research Council, PROFESSOR HOWARD NEWBY, Chairman of the Economic and Social Research Council and DR DAVID REES, Secretary of the Medical Research Council, were examined.

Chairman

158. Good morning, gentlemen. Thank you very much for coming, you are most welcome before the Committee. This session of the Committee is a particularly special one in the short time available to make this report on the structure and policy of the OST around which, as you are well aware, it is intended a White Paper will be published early in the new year. We found it was not possible to have evidential sessions which would individually be able to cover the range of the Councils which you represent and we therefore felt it right to have a session in which all of you, if you were willing, could come. Although there will be individual questions put to you we are looking at an overview of the Councils, what they do and their relationship to the OST and so on. I am particularly grateful that you have agreed to come in this rather unusual manner. We shall do our level best to ensure each individual Council here represented will have an opportunity to make his contribution and, indeed, questions will be asked by colleagues and myself to an individual Research Council, at least for lead responses in relation to the topics we seek to cover. I am most grateful. I gather you have had a little session next door to perhaps agree on some kind of presentation. I would like initially to invite you to identify yourselves. Have you got a chairman you have appointed for this session? There is a nod. It would be helpful if you would care to introduce the team around you, as we have identified ourselves.

(Professor Blundell) I should say the group which has been meeting has been the heads of the Research Councils. Let me introduce, first, Professor Howard Newby.

159. Perhaps you would introduce yourself first.

(Professor Blundell) I am Professor Tom Blundell, Director General of the Agricultural and Food Research Council. Professor Howard Newby on the far right is Chairman of the ESRC, the Economic and Social Research Council. Professor John Knill is Chairman of the Natural Environment Research Council. I should give the apologies of Sir Mark Richmond who has a prior engagement lecturing in Madrid and is unable to join us today.

160. He did write and explain. Thank you very much for that.

(Professor Blundell) In his place we have Dr Tony Hughes who is the Deputy Chairman of the Science and Engineering Research Council. Then we have Dr David Rees who is Secretary and Chief Executive of the Medical Research Council and Professor Graeme Davies, who is not a HORC (Head of Research Council), he is the Chief Executive of the HEFC.

161. Thank you very much indeed. If we may commence. There are five Research Councils and the HEFCs for England Wales and Scotland. I think it is reasonable to ask as an opening statement, and you will all I trust wish to respond individually to this: what are the Research Councils really for? What should be the distinction between research funded by Research Councils, the Higher Education Funding Councils on the other hand and industry in the third part? I think that is not unreasonable to upon up this view, afterall we are, as a Select Committee, looking into the structure and organisation of a ministerial office now appointed and we might wish to have the reassurance you all have a distinctive role. Can you justify that?

(Professor Blundell) Could I maybe lead off on that, although I am sure my colleagues will want to contribute to the discussion. It is perhaps right to start by defining the origins of scientific progress as coming from two sources. One, of course, is the science opportunity, the new, quite often unexpected, development that comes from following a pattern of science in the research laboratories, and the other is the technology driven research innovation, really the development of the old statement that science owes more to the steam engine than the steam engine owes to science. The Research Councils and the universities come together between those two driving forces for the progress of science in an area where it is quite often difficult to predict whether the applications will be industrial or for the public good, in support of policy. They come together, therefore, in a broad area of science. I would like to make two comments with respect to that science which flows from the description. The first is that basic science and applied science must be kept together and they are both the responsibilities of the Research Councils. This, of course, implies that both science and technology are the responsibilities of the Research Councils. Secondly, to make the point that transfer of technology is a continuous process and requires a continuous interface between the Research Council or university science and the industry or the Government Departments. That is, of course, the non-linear model, the to-ing and fro-ing of ideas between the different components: industry, the policy groups in Government for the scientists at the bench. I would like to make a further statement about the role I see of the Research Councils and the university sector and that is that their research should be organised into homogeneous bodies which bring together both basic and applied research. The Research Council heads would like to convey to you today the importance of maintaining the integration of the fundamental and applied science. We are very much against a separation of so-called basic science from those areas that could be perceived to be

[**Chairman** *Contd*]

supporting competitive industry at the present time. We believe that *all* our research has that potential and should be kept together.

162. Thank you, Professor Blundell, for that opening response. Perhaps I could ask Professor Davies to expand on his aspect of it.

(Professor Davies) Firstly, could I offer an apology to the Committee. I have a new funding council who are very sensitive to producing formal documentation and, in the absence of their scrutiny of it, the document I produced in a sense is a very short one to embrace policies which I am sure reflect the policies of my Council which are to be endorsed on 24th November when it meets prior to its formal submission. Having said that by way of apology I make the point we see our role as being a model one. We are responsible for one side of this very important dual funding stream of resources which flows into the universities. If you look at that data that we have produced you will find we are, of course, the largest single input into the universities, although we are not the majority inputer in that, the input that comes from Research Councils, from industry, from the health authorities, from other Government Departments is very substantial. We contribute something of the order of 45%. This is for underpinning the basic research and the strategic mission orientated work that goes on in collaboration with the Research Councils and industry. It also fulfils a very important role in maintaining the staff and physical infrastructure which is necessary for the provision of trained research manpower. We have an important role in sustaining the underpinning of research students and of research fellows who come from that research student potential. We also, because of the nature of our funding methodology, provide very important long term stability for the higher education institutions in that we have, as I see it, a foundation basis which flows fairly steadily with variations over a long period of time but they are long wave length variations. Within that funding we can provide for important areas of seed corn research and seed corn researchers, young people who perhaps do not always have easy access into the Research Councils as they build their reputation. We also provide the resources which institutions can draw upon to embark upon research initiatives which may be in anticipation of support which subsequently comes from the Research Councils.

163. Thank you for that. Do any other of your colleagues wish to make a comment?

(Dr Rees) May I answer specifically from the point of view of the Medical Research Council but in a way that illustrates, the general principles which Tom Blundell has proposed. Modern medical treatment and the existence of the pharmaceutical industry have both come about as a result of scientific advances and there is a long way to go. There is a lot of research/is needed to develop treatments which will be exploited in industry and which will improve the health of the population in areas like AIDS, mental illness and many others. Our contribution to that is through a balanced portfolio, from the basic to applied again the point Tom made. It is essential we keep in mind simultaneously, both the practical needs and targets and the scientific platform on which further advances will actually be made. In other words basic and applied research must be combined within the one operation. You asked about the distinction between research funding through the Research Councils and the HEIs; most of our work is done in the context of HEIs even if they are MRC institutions or units placed on HEI campuses. Most of our people who do the research are trained through HEIs so it is very important we have a symbiotic relationship between the Research Councils and the HEIs and that HEIs have the wherewithal to develop their own basis from which to enter into this partnership with us. You also asked about the distinction between the research which we Research Councils promote and research which is done in industry. I just quote the saying of one research director of a pharmaceutical industry, but I am sure it would be echoed by very many more, that in this research intensive industry, the research demands for product development are really stretching the limit of what companies can afford. Thus their R&D portfolios are becoming more and more targeted on delivering and testing products that they need them and so forth to the extent that they are in danger of losing their peripheral version of what other scientific advances and opportunities are coming along. Again, we have a symbiotic relationship in which we can help by providing them with a general picture of scientific activity within which their own focused developments take part. MRC is a mission orientated Research Council. We do research across the complete spectrum relevant to the improvement of human health and its spin off to applications both in the public sector and in industry. I think we should be thinking about not only what has been the remit of our research activity in the past and our rationale for it but what should it be in the future in the context of the White Paper. I very much welcome the appointment of a Minister for Science and the declaration of intent to produce a White Paper implies a national strategy. I would hope the kind of activities I have described can be developed into a component within an overall national strategic picture which will come out of the White Paper.

164. Dr Hughes?

(Dr Hughes) Thank you very much, Chairman.

165. We will have to ask you to be a little brief so we can get through the questioning.

(Dr Hughes) I would certainly like to endorse very much what Professor Blundell said about the importance of both science, and engineering and technology, in this debate. I think we should remember that the Office of Science and Technology, which like Dr Rees we very much welcomed in its

[**Chairman** *Contd*]

formation, is concerned with both science and technology, whereas there is a tendency, I think, to associate the debate with science only. SERC, of course, spans science and engineering. We believe that it is exceedingly important that both of those arms are recognised in this debate and that the links between them as well as between basic and strategic and between strategic and applied research are very important. SERC, of course, has a particular role in supporting fundamental research that some people would describe as driven by curiosity rather than by potential applications and I think that should not be forgotten also. We work entirely or principally through the support of the HEIs in research and we are, therefore, essentially a funding body rather than a doer of research ourselves. There is one particular point I would like to add to anything that has been said so far and that is the importance of training at the postgraduate level. The training of young people in research degrees and indeed in doing postdoctoral research and becoming expert in research is a very important role for all of the Research Councils, which I think it is vital to stress as part of the role of the Research Councils in supporting research in science and technology for the benefit of the UK as a whole. So that is something which SERC is very deeply involved in. One of our largest elements is the support of postgraduate training; I do not believe it has been mentioned so far and I think that point should be made.

166. Professor Knill?

(Professor Knill) Could I pick up from your initial question where you referred specifically to industry? The Research Council system is, of course, looking broader than industry alone. We are concerned with public good issues; we are concerned with issues relative to the quality of life. My Council, of course, is interested in the environment and we, in fact, are the major deliverer of environmental research results in this country and we deliver it in various ways and we use both the HEI system and our own research institutes depending on which is appropriate for particular needs. Like previous speakers I also say basic research is essential to the underpinning of that mission and in some way we require engineering and technology as part of that underpinning structure which enables us to plan and carry out our research programmes. Equally, we believe there to be, in a sense, a seamless whole between basic research at one end and applied at the other. We carry out research through contracts for industry and contracts for Government through our research establishments and we regard the research activity relating to policy development and strategic research relating to the formulation of policy for the future as being a particularly important part of our activities. Certainly in relation to environmental research underpinning this country that has been a particularly successful deliverer of results. –wit - (Professor Newby) I think if one asks the question what is the problem which the White Paper is looking for a solution to, clearly when one looks at the scene as a whole one is struck by the historical success of British science and our failure to convert that success into economic competitiveness. I think anything which is introduced which puts in place further barriers such as a quite artificial distinction between basic and applied research attempting to convert our scientific excellence into economic successes is a mistake. I would go further than that and say that of course economic competitiveness is as much a market led as it is a science driven issue and I would, therefore, like to underline one of the points that has already been made. It is very important not to see the link between the science base and other economic competitiveness, or indeed improvements in the quality of life, as being purely linear. They are strongly interactive and we need a two-way flow of technology people and cash, a two-way flow not one-way. We should, therefore, not be introducing additional barriers to that process.

Sir Trevor Skeet

167. Could I raise one general point. Professor Blundell says Research Councils should be homogeneous bodies but can that actually be indicated by the SERC?

(Dr Hughes) In the sense of covering a wide range of points of the spectrum, yes I think the SERC demonstrates that to some degree, in that we cover a wide spectrum from basic through strategic to the boundaries of applied research.

168. That is heterogenous.

(Dr Hughes) That is one spectrum. We also cover a spectrum from what is generally called responsive mode behaviour, where we react to proposals made to our various component parts by individual academics, through to more directed programmes which are shaped in order to try to meet more specific goals, such as in some of our Directorates, for example, in biotechnology. We certainly, therefore, do cover quite a wide range of the spectrum and in that sense have some homogeneity and have our interfaces with other councils in particular areas.

Mr Batiste

169. My question comes very much out of what Dr Rees has said, and the previous point made by Professor Newby we will come back to this. It is this problem of converting science and technology into marketable products and wealth creation within the UK. What I am trying to probe at this stage is the mechanisms why some areas seem to be considerably more successful than others, for example the pharmaceutical industry spends very much more on R&D than any other sector of the UK economy. As I understood the comment that was being made by Dr Rees the consequence of that is a great deal of the technology side, near market activity, through to the market, is taken on by industry and you operate on

[**Mr Batiste** *Contd*]

the periphery trying to open their eyes to other opportunities. When it comes to SERC you have a much wider range of industries with a very much poorer record of research and development. How do you feel operating on these difference you can achieve a greater stimulus to the conversion of science into wealth creating products?

(Dr Hughes) I think you have put your finger on what is for us a very real difficulty.

Chairman

170. We have perceived that.

(Dr Hughes) The performance of different sectors of industry clearly differs greatly in the extent to which they have been able to exploit science and technology and convert it into economic strength. You mentioned pharmaceuticals as one successful area and we play our part in interacting with the pharmaceutical industries in chemistry, biochemistry, biology, and indeed in engineering, but they are of course not alone as a successful sector of industry. There are other successful sectors such as oil and gas; Rolls Royce is often quoted as a successful example of the exploitation of very advanced technology. We certainly have encouraged over many years the various schemes to enable academics to work closely with industry in the successful areas such as those we have just covered and, indeed, in those areas considered to be rather backward compared with our competitors abroad, such as mechanical, and perhaps electrical, engineering.

Mr Batiste

171. Where it is obviously very successful, where there is a high interface between industry, and I only use pharmaceuticals as one example, obviously there are many others, is where the success rate is clearly very poor and you see yourself as having a mission to improve the situation. How can you draw the industry in its R&D policy further towards participation in the things that you would regard as important?

(Dr Hughes) I do not think in any sense we alone can do that and certainly would not claim we would ever be in a position to be the only player, because we can only do a certain amount to address the connections between basic and strategic research and some applied research. In some senses we are only touching the tip of the iceberg, but it is an essential tip to touch. What I think is probably true, although it is dangerous to generalise, is that the whole process of converting the kinds of research and training that we support, and the other Councils support, into effective partnerships with industry is much easier when the sector of industry itself is investing in at least strategic research, not necessarily basic research, but where it has an investment of its own in strategic research. The pharmaceutical industry is an example of that and some of the work at Rolls Royce that I mentioned earlier in developing engines, aero engines, is in that category, and involves very advanced fluid of dynamics, for example. Where you have that in industry itself it is undoubtedly more easy to make an effective bridge.

172. I understand that point and one recognises you are only responsible for a segment and others have to contribute as well but, nevertheless, from where you are you must have a clear perception of that which is within your grasp to achieve and others ought to be achieving, than trying to pin down what you think could be done in the R&D field and what could be done by others?

(Dr Rees) Could I have a go on that since you referred to the pharmaceutical industry? The reason why they are so research hungry is that they realise that without a technical edge they are dead. We have seen a series of mergers between pharmaceutical companies, partly instigated because some have products in the pipeline and others which do not. In other industrial sectors the dependence on technical edge may not be so crucial in choosing as an example one with which both MRC and AFRC are also engaged in I could cite the food industry. This industry has in the past been able to choose between, on the one hand, making research driven technically led products and, on the other, the attractive packaging and presentation of what is already technologically available. I think that now is beginning to change with more public consciousness of health. With the public looking at the health consequences of eating what they eat and taking notice, for example, of the publication of the Health of the Nation, manufacturers may well have more need a technical edge. This generates an area in which there is a basis for a partnership with MRC, to answer your question. I think the way forward is to identify areas where technical development can give industry an edge, and then form strategic alliances based on these, to get into partnership and reinforce the research process within those industries.

(Professor Newby) To take up Mr Batiste's point, there is not only a distinction by sector but also by size. The good large companies are doing enough often to seek their own strategic enterprises. There is a real problem with small and medium enterprises. You use the word stretching, stretching the research to meet industry or vice versa. When one looks at SMEs and you can not stretch both sides together. I was a member of the group put together by the Prince of Wales that made recommendations for an intermediate institution, the Faraday Centre Concept, and also for interested parties and interested stake holders in technological innovation. British scientists are good at science, they are not very interested or good at being businessmen. Similarly, many businessmen are not liberate in science or interested in basic science and perhaps we need some intermediate institution to enable a two way flow between people and ideas to take place.

173. Taking up your point about strategic alliances, you would not yourself, as a Research

[**Mr Batiste** *Contd*]

Council taking up the point, see yourself as having a role in bringing together large companies and small companies?

(Professor Newby) Very much so.

Chairman

174. You would all regard that as one of your endeavours?

(Professor Newby) Yes.

(Dr Hughes) I was asked the original question, Chairman. We have addressed very recently the issue of whether we could somehow do better, as it were, in the flow interactions in both directions with SMEs. We have concluded broadly that that is exceedingly difficult to do except in certain instances where there are research-aware SMEs, which is not by any means the majority, it is a small minority. Therefore, our strategy towards encouraging academic-industrial collaboration should be principally with the major players who are involved in strategic research and where we can inform and encourage these sort of partnerships that several people have mentioned. We should not neglect the SMEs and we have some schemes like the Teaching Company Scheme which we support together with DTI. That does address that sector rather more than most other schemes. There have to be a range of approaches.

Mr Batiste

175. I was anxious to hear from the Higher Education Funding Council.

(Professor Davies) The emphasis has been, in a number of comments, about partnerships. The way one might seek to encourage better utilisation of the foundation I talked about before was to ensure it was not too homogeneous. The funding council for some years, and increasingly, has pursued a policy of high selectivity where one tends to focus funding on centres of excellence. So you build foundations which can link more closely with industry. There is strong evidence to show this policy, this duality, has had a real effect. Some data I have produced show in real terms the higher education institutions have increased their intake of support from external sources other than the funding council, in real terms something like 15% per annum over the last three years. This is an important way of dealing with some of the interactions and we have both direct and indirect policies which encourage commercial institutions to do that. There is a small sector of our funding which reflects the success with which higher education institutions interact with industry and commerce.

Mrs Campbell

176. Mine is a question for Dr Hughes about the training of post graduates. The question is in two parts, maybe I can ask the first part and come back on the second part. We have had complaints from some of the industrial organisations who have made submissions to us about the training of post graduates. There have been two specific points made and one was about the inability to work as part of a team. I wondered if you had ever considered getting people to submit joint PhDs, joint projects rather at post graduate level? The other point was the lack of ability in practical work because on the whole post graduates in higher education institutions do not have at their fingertips the very expensive equipment that is available in industry?

(Dr Hughes) We have a number of schemes that encourage joint projects of the kind I think you are referring to. The most well known of which is the CASE scheme—Co-operative Awards in Science and Engineering—in which a research student at the PhD level undertakes a project which is collaborative between the department in the university or polytechnic and a firm. As part of that process they have an industrial supervisor as well as the academic supervisor and spend some time working in industry. There are some other more specialised and smaller schemes which go further in the industrial end of that sort of process, such as the Parnaby Engineering Doctorate which we have just started this year.

177. That is still an individual effort on the part of the student. Do you have any projects which are joint projects, a number of students undertaking those together and producing a joint thesis at the end of it?

(Dr Hughes) That certainly happens up to a point. We do not have any specific arrangement for doing that other than the allocation of studentships, for example, to our inter-disciplinary research centres, or where we have a process which in the trade is called ear-marking which can associate the award of studentships with particular projects. So it certainly happens and it also happens very much in areas like astronomy, particle physics and other large parts of physics, or information technology, where we have large grants to departments and they will associate with those relatively large bodies of students. I think it would be a mistake to think it does not happen because it happens a great deal. Having said that, one final thing we would very much like to see, and are taking steps to try to encourage more of is, the greater training of PhD level students in skills other than the very specific research topic they are undertaking, including intellectual property, including some appreciation of business and also taking up your point I think of including formal training in practical skills, workshop activity and so on.

178. Can I go on to the second part of my questioning which is to do with the number of candidates declining. I think recently there has been an increase in the number of PhD students but over the 1980s it has declined. Do you see women, the whole post graduate area being made more attractive to women in order to attract more people into that area and if so have you got any plans to

[**Mrs Campbell** *Contd*]

make the post graduate training more attractive to women? Several women have made the point to me it is difficult to fit in maternity leave, family leave, part-time work and so on into that structure.

(Dr Hughes) To take the first part of that first, I am not sure you are right that the numbers have declined. I think the statistics would show that the number of PhD students in science and engineering has actually increased consistently over the late 1970s, 1980s through to where we are now. The demand for such places has increased very substantially in the last couple of years, which we suspect is due to the difficulty of getting other jobs as much as anything else. To move to the rest of your question, I agree that there are some real difficulties in flexibility of that sort in some of the schemes which presently operate. We are gradually trying to free those up. Having taken a number of restrictions off in recent years, we are about to look more seriously than in the past, at whether we should support some pilot schemes in part-time post-graduate study. All of these things would help not only women but perhaps other minorities. Of course women are not in an overall minority, an unfortunate slip on my part: a minority in terms of the population of scientists and engineers. Other people also could be helped by this.

(Professor Newby) We have looked at a number of difficult areas in some depth. I chair the ABRC's Manpower Sub-Committee. I think it is important to realise Research Councils are constrained by university degree regulations. They determine the nature of the PhD and the nature of the PhD is in fact very diverse from one discipline to another. It follows on from that that there is a major issue about whether through the training embodied in the PhD there is a balance between training and research skills on the one hand and production of a thesis and original contribution of knowledge on the other. The two are not altogether complementary. My own Council has introduced a series of training guidelines for formal training and research skills to be undertaken during the first year and has met some resistance from some universities to that, but I think it is something which is increasingly gaining hold. It will not get over this problem of individualism you have referred to, university regulations on the whole do not permit jointly submitted theses. A last point on the position of women: my own Council has introduced a scheme for part-time PhD students and I know other councils are looking at this. This may be one element of flexibility we can use to encourage more people.

Mr Strang

179. Can I address my question to Professor Blundell. In the AFRC submission you referred to the Research Councils having a key role in nurturing areas of promise and in evaluating research. Do you think responsibility for deciding priorities within the science budget should remain with the scientists or do you think there is scope for more Government direction of national priorities?

(Professor Blundell) Thank you. I think the answer to that question depends on what kind of science one is speaking of. As much of science and innovation is science driven one must have scientists involved, and of course those scientists are to be found in industry, Government departments and academic departments. However, I am sure Research Council bodies at the level of their Councils and, at the level of their Research Committees, should have representation from industrialists and policy makers as as scientists. Certainly my own Council has, it includes five or six industrialists and several experienced scientists and policy makers from Government departments. There already is a mixture of scientific and policy advice. The question then is what is the relationship of the technology and science driven evaluation with Government policies and preferences? There certainly is a role, I would think, in all Research Councils, certainly in our own Research Council, for industrialists with a much broader background and without a scientific training. In my own Council my Chairman, Sir Alistair Grant, is not a scientist, he is the Chairman of Argyll. Of course, he provides extremely useful input into our processes of scientific merit review and into evaluating new areas of opportunity and new requirements of the industry. I am sure there is a requirement and increasingly a need for that kind of person to be involved with the scientists in defining the priorities. It goes back to my original statement that Research Councils are really about bringing together the bottom up science, driven ideas, where you have to have scientists involved, with the industrialists and policy-makers. I think we have the balance fairly well arranged.

Mr Williams

180. I would like to ask Dr Hughes, in your brief you cover such widely differing sciences, how do you come to decisions when there are such very dissimilar subjects from nuclear physics all the way to biology?

(Dr Hughes) That is, I think for all of us a difficulty which just happens to be particularly sharp in the case of SERC because we do cover such a broad spectrum. The decisions at that level have to be made with the advice and discussion in our Council, which is the top level body; the balance between parts of our total programme is a matter for the Council acting as, if you like, our senior peer review body. The Council has to take into account in doing that job a very wide range of criteria spanning from scientific quality, as it were the absolute measure of the quality of science or engineering research which is involved, right through to more political factors involving often our relationships with partners and other countries. It is done at the level of our Council and the other decisions are

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devolved down to the sub-structure within our Council, to Boards and Committees and sub-committees.

181. Do you think you have got the balance right? Very broadly, something like 18% of the budget goes to nuclear physics, 15% to astronomy, there is a further chunk from the physics' budget involved again with nuclear physics, so about 40% goes to pure physical sciences and the balance, when you look at the amount chemistry gets and biology and mathematics, is that the right kind of balance? You referred earlier to the importance of training. You are training young graduates into useful jobs. I can see in chemistry a lot of the graduates go into the very successful chemical industry, but I cannot really see the value of highly trained post graduates in astronomy and nuclear physics, they are more expensive to train on the one hand and really in a commercial or industrial sense surely less useful. Is the balance related to society and industry's priorities?

(Dr Hughes) To start from the end of your question, yes, the actual research which the research student in, say, particle physics or cosmology will do during their PhD is genuine pure research of the literal kind. What our statistics show though is that if you track the careers of those PhD students when they have completed—and you have to remember they are not very large numbers compared with the numbers we are supporting in other areas of science and engineering (out of our 5,000 students we support per year, about 150 or so are in those fields, for example) when we track them through about half of them end up working in industry doing work that is not directly related to the research they did for their PhD, but where they are using the general skills they acquired in the way of working. I think it is a more complicated question and issue than just what they actually do their PhD on directly.

(Dr Rees) I wonder if I can come back to Mr Strang's question. This is a very good illustration of the kind of issue you were raising when you asked whether questions should be resolved by Government or by the scientists. If we are going to have a strategy for the science base, which I very much hope we are, then questions like should we do more engineering or less engineering, have we got the right sort of chemistry and life sciences, where are we internationally and should we do more or less, really all need to be faced up to and looked at and addressed. I just wonder whether the distinction between science and Government, I mean who decides, is really such a real one. The Chief Scientific Adviser is a scientist. The Research Councils will give appropriate input so that they can make their views felt, independent advisers make input at many levels. Even then, decisions at the top levels of Government will be at such a macro level they are going to leave plenty of scope for individual scientists and Research Councils to work out the best ways of addressing them at the tactical level. I think we do have to answer the questions but I do not think there is a necessary conflict between scientists and the Government.

Chairman

182. I am glad to hear you say that. This is one of the questions the Committee might want to ask of the group, maybe there has been strategic direction given from the Research Councils themselves or from Government. Could I ask the question of each of you has there been a shift from responsive led funding to directive funding and if so what are the reasons for it? What should the balance be? Perhaps you would care to comment on it.

(Professor Blundell) There certainly has been a shift towards directed mode funding. In the AFRC we have been able to identify new technologies, for example new opportunities in plant molecular biology and, in other basic techniques, where we require more scientists and more scientific activity. So we have targeted areas with broad programmes but, having said that, I think the distinction between directed mode programmes and responsive mode programmes is not quite as strong as it might seem. I believe the role of the Research Council is to define an area where more research activity is required, to define the objectives and to define the value of that research and then to get the research community involved in making the proposals of how that will be advanced. All of our directed programmes have been brought forward in that mode. They have been extremely successful in shifting the balance from what was a traditional agricultural, biological community to a community using very new technology. In the last 10 years 50% of the institutes have changed in terms of their techniques.

(Professor Davies) In a sense Professor Blundell put an important word on the table when he said in seeking to operate in a directive mode Research Councils can identify new scientific technologies and new opportunities. One of the advantages of the current balance between the funding stream from Government and from the funding Research Councils is those new scientific technologies and opportunities can be brought through the higher education research institutions without there having to be that initial direction. They can construct this through their own inter institutional inter-action. So when the priority area is identified then the resources exist to be called upon. That is a very important part of trying to create this foundation you make reference to.

183. Is this the objective of your Council to do it in that way?

(Professor Davies) Indeed.

184. It is not just an osmosis?

(Professor Davies) No, it is an objective. To refer back to the comments about the mix. The mix of the Council is such that it has people, both academic and non academic. In the way we disperse our funding

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we seek to reflect the steering mode rather than a direct funding mode to encourage particular areas of endeavour, whether they be in science or technologies, to enhance their own base.

185. Dr Rees?

(Dr Rees) It clearly is very important to have a mode of research funding which is responsive to the good ideas and creativity of the research community. I would hope within my own Council that investment in this mode has not diminished much over the last decade or so. But I would also like to say that it is important to keep this issue in perspective because one has to address many other objectives at the same time. It is no use responding to a research proposal if the person does not have the environment and infrastructure to do that research well. An increasing amount of effort is needed—as science costs more—real money to put into creating research environments in which good work can be done effectively. The human element also needs to be addressed, coming back to Mrs Campbell's question. Training for team work and catering for women's family responsibilities can be addressed if you create appropriate environments—for example —to foster team spirit and so on and get away from areas which are traditionally areas of doing a PhD and giving somebody a problem and sending them off to do it themselves. Finally, the long term versus the short term. If we are constantly responsive and dotting about from one idea to the other, we may miss out on the opportunity for a well organised long term attack on an important problem area, like AIDS. I think responsiveness to research ideas is important but we must not get it out of perspective.

186. Dr Hughes?

(Dr Hughes) I think it is another example of one of the balances we have to make. Mr Williams raised earlier the balance between different types of subjects. We are constantly trying to address the balance between different approaches, responsive at one end, directed at the other. There has been over the years, as far as SERC is concerned, an increase in the amount or component of our portfolio that is involved in more directed programmes. There has been a feeling recently that we might have gone a mite too far, but that has been a trend over the last decade or more. For instance, we have doubled our resources into engineering research and 70% of our engineering portfolio tends to be more directed than responsive. I would like to echo something Tom said that is very important. Where we have a directed programme so-called, it is not a top down directed activity that says to academics: "Thou shalt work on this". We define the area and look for proposals from the academics, or others making them, in relation to selecting them on their merits.

187. You are the gentle persuader?

(Dr Hughes) Yes.

188. Professor Knill?

(Professor Knill) There has been some move from the response mode to directive mode. We have increased the number of responsive mode studentships and reduced the number of directive mode. At the same time we have increased the proportion of spend in HEIs. One has to be careful as to the mechanisms of spend in different directions. Equally the definition of responsive and directive is a difficult one. If one research worker has an idea that is a responsive mode, if three of them get together, take that idea and work it out amongst themselves, which is getting more people working, I think it then becomes a directive mode. Certainly the environmental area, if you want to solve the world's environmental problems you have to work as a team. It is inevitable my Council has moved towards community research projects where we are seen creating between communities our own institutions, HEIs, and using our own facilities working on the international base. On an international basis it means there is an overlap of research activity and one benefits from the use of ideas and research activities in a good way. I see this slight change as being really rather healthy as far as science is concerned. Our latest community research project, which is a multi-million spend per year, is called the Land Ocean Interaction Study. It is no surprise that is concerned with the coastal zone which the Government has tremendous interest in. A lot of interest in the coastal zone study has stemmed from the NERC's first project in 1978, the North Sea project, which is in its second day of its seminar at the Royal Society today where we are presenting the total results of that second part of the work. I think the relationship between responsive and directive, I think one need not be too much worried about. One has to watch the whole time. The directive research acts in exactly the same way and reflects directly the responsive mode.

189. Professor Newby?

(Professor Newby) We have increased the proportion of our research budget going into the responsive mode. My Council monitors at the margin very closely the quality of work we are funding that is under grants, centres and targeted programmes. I cannot resist saying (if you will forgive me) at this particular point in time, I hope the Committee is aware of the fact if we receive unexpected or less than expected increases in our funding, and they all fall in the first year, we have very little flexibility to respond other than to place those cuts disproportionately on grants and on studentships. That does very often create a perception which is long lasting.

Dr Bray

190. On the question of responsive and directive, is there not the danger of rechristening the same work and the same people and putting that under different heads? There is a directive programme at

[Dr Bray *Contd*]

the Rutherford Laboratory and its good people are free to put in a responsive mode application and to continue doing the same thing.

(Professor Blundell) The AFRC in 1986 had 6,500 people in institutes of the rather classical kind of agriculture and biology; at the present time we have 3,000 in institutes and over 1,000 in universities.

191. The AFRC has made a very major change; the SERC has not made as big a change.

(Professor Blundell) Out of 3,000 people in institutes, 1,000 of them I would put in the class of traditional biology and 1,000 of them using new technologies. We have certainly changed and used the directive programmes to change the nature of the science.

192. I understand that. Could we have SERC respond?

(Dr Hughes) Could I respond to that? I think Dr Bray has perhaps directed his attention at the wrong place. He mentioned the Rutherford Appleton Laboratory in the context of directed programmes. Our directed programmes are almost exclusively run through the HEI system and our programmes, to which people make applications, come from individual HEIs. There are some cases where the staff in our laboratories provide some co-ordinating support for that but not in undertaking the research itself. I think it is important to make the point that the SERC laboratories undertake very little research and the doing of research. What they do is to provide facilities for the use of academic researchers and the vast majority of their effort is devoted to that.

193. Is there not also a danger of the rechristening of activities as between the boards, that the run down in expenditure in the nuclear and astronomy boards has been matched by the rapid increase in the Engineering Board? When you go and see the Engineering Board's operations many of them are very good science, pushing atoms around on materials in a Materials Commission. Great Stuff! It would, in an earlier time, have been done by the science board.

(Dr Hughes) I do not think that is a fair comment.

194. How many engineering products have directly emerged from the work of the Engineering Board?

(Dr Hughes) The Engineering Board has grown by a factor of about two in the resources it deploys since the late 1970s. It supports work in engineering departments and science departments, there is no doubt that the amount of support it has put into engineering departments has grown over that period.

195. Is it not the case that SERC has been under great political pressure to increase its work for the engineering board? It has responded but it has had great difficulty maintaining quality, for example, in the inter-disciplinary research centre in engineering design. There was great political pressure, the centre was established but it was wrapped up within two years.

(Dr Hughes) That was an unsuccessful inter-disciplinary research centre.

196. It was in response to political pressure?

(Dr Hughes) It was set up initially with some political momentum, yes. As for regarding the subject as being of some importance, which I think it still undoubtedly is, design was seen as a subject which ought to be among the first of the IRCs. We have not changed our view on the importance of the subject. We still support design, in other words.

197. On the question of the balance of interest of research students, the Research Councils generally do not keep long-term records of what happens to their post-docs in the way a business school 20/30 years later is able to say what the salaries of their graduates are because that is a primary advertising feature for the attractiveness of the business school. Are you able to say 20 or 30 years on what your previously sponsored doctorates are doing?

(Dr Rees) No, but we ought to. That is something we ought to develop.

Chairman

198. It is something you are collectively of a mind you should maintain?

(Dr Hughes) It is something we would dearly like to do. We collect first destination statistics of approximately 5,000 postgraduates each year having been funded by SERC. We do not at present track those through, except in special areas, beyond that.

Dr Bray

199. In responding to what you have outlined, the special agencies involved, that is individual universities, their students, funding councils, Research Councils and other funders and customers, subsequent employers and, indeed, the people themselves, have a complex of influences bearing on the system. Is there missing in the system somewhere some person, or body, who looks at that as a whole and says: "This is the way the system needs to oblige"?

(Dr Rees) I think 20 years is going to be very difficult but we have thought, for example, of using devices like making it a condition of awarding a grant that some record is kept over some period of time as to what happens to the staff employed on it. I think there are ways in which we might be able to do better. I agree, it is essential to see what our research funding has generated in terms of training and careers.

200. Could I ask you one more question concerning the macro-economic modelling Bureau jointly funded by ESRC, the Treasury and the Bank of England. It has been very substantially cut

[Dr Bray *Contd*]

recently, the balance being maintained when ESRC reduced its expenditure and the Treasury and the Bank of England pro rata. What is the ratio of ESRC to Treasury and Bank of England support?

(Professor Newby) We capped our expenditure by 55% or 1.7 million, whichever is the higher. For the reasons you have mentioned we ended up putting in 1.7 million. At the moment the ratio is in the order of 75% ESRC and 25% between the other two parties, of which the Treasury is the vast majority.

201. It was a very major cut?

(Professor Newby) Yes. This is the macro-economic modelling as a whole. You referred to the Bureau at Warwick also but those are two different issues.

202. Sorry, the consortium.

(Professor Newby) Yes. There was a cut in the order of 30%.

Chairman: Could we turn to the advisory structures.

Sir Trevor Skeet

203. Now we have set up the new Department, the OST team, does not the whole system become a little too complicated? Is it now necessary to have the ABRCs sandwiched between Government and the Research Council?

(Professor Newby) My answer to that is yes, or a body of that kind, for two reasons: one is I do not personally believe it is conducive to the public good to have ministers making decisions directly involving the closure, or for that matter the establishment, of a particular scientific facility. The second issue, which probably follows on from that, is we are seeing whether we like it or not, the increasing separation between teaching and research in universities. This is something Professor Davies may wish to comment on. I do worry we are on the one hand working towards a separation of teaching and research and if that were to be left to a budget between Government and the scientific community you would be heading dangerously close to the situation from which the vast majority of Eastern Europe is trying to escape.

204. Can I pursue this. I see in your paper OST A30 you indicate as far as Research Councils are concerned you would keep the ABRC but add to it proposals coming from Government Departments and you would extend it. I think you are divided between yourselves as Research Councils. NERC in their paper 7 indicate they were the Board for the science base that reconstructed ABRC. MRC in paper 18 want a sound science and technology co-ordinating and advisory board with a sub-committee modelled on ABRC. Surely is this not becoming all too complicated? We are concerned with basically science and to get the right structure should we not leave this to the Department itself? If I can add one further observation, Sir John Kingman says this: "I hope the OST can become strong enough to stand on its own and cast away the crutches of ABRC and ACOST".

(Professor Blundell) I am not the Chairman of ABRC. I would like to make a distinction of two roles which I think must be indeed separate. You quite rightly say that in detail the comments coming from the different Research Councils are different but in general they make the point that we need two bodies. One body is really, if you like, a market advisor to the proxy-customer for basic and strategic science, and that is with OST at the moment. We should have a body like the ABRC which can look at the science programmes in that strategic and fundamental area. That body should give advice to the Minister about expenditure on the science vote. I believe that is equivalent in many ways to the advice that will come in the various Departments of Government about the requirements for science in their policy areas. But, above that I believe we need a policy advisory group, to look across the broad range of science, not only at the strategic science funded by the OST but also the research in the Government Departments and in industry and ask the questions: "Is the balance correct? Are there gaps? Are we emphasising the right areas?" That is a very distinct role from the role of an ABRC like body and it must have a much broader vision.

205. Thank you very much. I am very much obliged for that answer. The only Research Council which has not answered this specifically is the SERC. After all, they are the biggest Research Council, they have got £520 million a year, some of the others are minute. What is the view of the Research Council, should we keep the ABRC?

(Dr Hughes) We addressed that I thought in our brief, Chairman. I think we are not all that far apart actually. As far as the specific point on the ABRC is concerned, what we have said is that we believe a spending department which is responsible executively for a certain budget, which in the OST's case is the science vote which funds the Research Councils and the Royal Society and the Royal Academy of Engineering, should decide for itself how it is going to call for advice on that function. Therefore, it should be for the OST to decide whether it needs an advisory body somewhat like the ABRC, reconstituted, or whatever, but to give its Minister advice on the disposition of its responsibilities across the Research Councils.

206. What you are suggesting is it could be an in-house outfit?

(Dr Hughes) Yes.

207. It could be decided by the OST itself without having the ABRC at all?

(Dr Hughes) It could be in principle, but it would be for them, I think, to decide whether they are going to need an advisory body to help them do it. My personal feeling would be that as with other

[**Sir Trevor Skeet** *Contd*]

Government Departments they would need some sort of advisory body to advise the OST on that disposition.

(Dr Rees) We have all sent in our papers separately and I too, when I read them, was a little bit alarmed that we appeared to be saying different things. In our pre-discussion today we agreed that if there are any differences, they are really only of emphasis. Essentially the Minister for Science has two jobs. He has to look out across Government Departments to see the relationship between different science programmes and he also has to look inwards at each of the Research Councils in his own Department to get them right. He will need expert advice but the expertise and perspective that needs to be brought to the two is qualitatively of a different nature.

Chairman

208. Would that be broadly agreed?

(Professor Blundell) Yes.

Mr Strang

209. It is interesting to get different ideas on this proposal and it will be addressed in the Government's forthcoming White Paper. On this concept of a national science committee and expanded ACOST, to all of you this is desirable, there should be some national advisory body with eminent scientists and industrialists on it who would advise Government. Would it be your view that the publication of any report by that body would actually be published? In other words, their deliberations would be part of the broader debate in Parliament and the country. That is the first question. The second question would be would this new goal of the ABRC be a different one in the sense you would not normally expect their deliberations to be anything other than private to the Government? Finally, the deliberations of the other body would impinge on the ABRC but in essence the ABRC would be a part of the complete Government machinery?

(Professor Blundell) I think there is a very strong advantage in taking advice whether it is from ABRC or from its successor that has to be fairly small and not too dissimilar from the present ABRC. I believe the advice coming at that level and also advice at the higher level is very much advantaged if it is published because it creates confidence within it the scientific community. I think we have had a lack of confidence through a lack of knowledge and quite often the heads of Research Councils have been in a position where they have been supporting the view that is generally supported in the community but because the advice has not been published it is not clear that position is maintained.

Chairman

210. Is that the position of all of you?

(Dr Rees) I think there may be some very important things we would want to say to the Minister which are best said privately in the first instance[1]. This question of openess is not peculiar to science, it is a general one I think. I agree we should be as open as possible but to have an efficient operation it may not be possible to be in complete public view all the time.

(Professor Knill) There will be no difficulty in ABRC publishing the annual report. Could I refer to Sir John Kingman's remark. It is important to bear in mind in 1990 ABRC was reconstituted. Before that date I did not attend all the critical meetings. It has now changed in character. ABRC has changed dramatically in the last two years.

Sir Trevor Skeet

211. I wonder if you could say something on the basis of the membership of ABRC? If it is going to be kept could it be improved by expanding its base?

(Professor Davies) If I can comment on that. We as a funding council, we are in the very directive mode we have been discussing but we do appreciate the value of an over-arching body, whose steering intentions are evident to the funding council. At the present time, with the reconstitution of ABRC, that linkage has been broken and we have put in place informal mechanisms of inter-action with ABRC and the heads of the Research Councils. I would express the view personally that, in reconstituting the over-arching body it would seem important to ensure the funding councils also have a substantive role in being able to have the access to advice and to be able to influence it.

Mr Batiste

212. Before we move on to the composition of ABRC, I was a little disturbed by one of the earlier comments I think from Dr Rees about the balance between openness and confidentiality because I would have thought if it was operating on that two level basis, that part of your advice was going to be public and part in private, the temptation is for your various Research Councils to play to the gallery in public and give contrary advice in private. I believe that would be quite useless from the Departmental point of view.

(Professor Blundell) I think we should publish advice. There are bound to be opportunities for discussion between heads of Research Councils and the Minister. They give ample opportunity for expressing concerns.

Chairman: I think the Committee will understand there could be and should be confidential

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[1] *Footnote by witness:* Especially when ideas are at an exploratory stage. There may be no point in a major public debate on a development which may never happen.

[**Mr Batiste** *Contd*]

discussions. The group as a whole should have a basis on which public exchange can be made which surely would be sensible.

Dr Bray

213. Can we be clear about the current practice. You have told us about the change in structure, the ABRC having heads of Research Councils being full members, and having more of an executive nature, but in addition to the ABRC the heads of the Research Councils also meet the OST, the accounting officer of the OST, is that the case?

(Professor Blundell) Yes.

214. It is a Permanent Secretary that you meet?

(Professor Blundell) Yes.

215. Does the Chief Scientific Adviser attend?

(Dr Rees) The case law still has to be established.

216. You have got this curious function by which ABRC submits advice to the Minister, then the heads of the Research Councils separately meet the Permanent Secretary and the Ministers, the Chief Scientific Advisor does not necessarily attend?

(Dr Rees) I do not think we can say that, the protocol has yet to be established. The Permanent Secretary is coming along to the next heads of Research Councils' meeting and the Chief Scientific Advisor is coming with him at this first exploratory meeting.

217. You are the accounting officers for your Research Councils?

(Dr Rees) Yes.

218. You answer to a superior accounting officer and that accounting officer is now a Permanent Secretary of the OST. You meet him directly, the Chief Scientific Advisor is not in that line?

(Professor Knill) My meeting is tomorrow afternoon, I am not sure if the Chief Scientific Advisor will be present or not, I do not know. I will find out tomorrow afternoon.

Dr Bray: Obviously we were in difficulty, the heads of the Research Councils were not in the line, it was carved up over their heads in ABRC and now it is carved up over the head of the Chief Scientific Advisor. We have had the present system operating through a very fraught public expenditure round and it is now out of their hands because we are having the Autumn Statement next week, you do not know what the outcome is and we certainly cannot ask you.

Chairman

219. In any event I think in your questioning you have paused, Dr Bray. It is clear as yet there has not been a regime established but your wish would be, or your indication would be, that it would be helpful if the Chief Scientific Advisor was present?

(Professor Knill) Yes.

(Dr Rees) I think we need to ask the question "accountability for what?" I see no difficulty in principle with being accountable to Richard Mottram for proper conduct and proper use of public money but I think it is important to have another line of accountability about delivery of research results and trained people, within the context of the Government strategy. That, I think, should quite firmly come under the direction of the OST and the Chief Scientific Advisor.

Dr Bray

220. There is no relationship between work and money?

(Dr Rees) Of course there is—it's called value for money; of course.

221. Can I ask a question of principle in terms of what you are trying to achieve. The Research Councils have a variety of sources of income, they accept contract work, they have work from inside Government and from outside Government and they are largely financed by the science budget. Should not the case be looking at it objectively from the point of view of science as a whole if there is a problem, the global environment or urban renewal or new materials in semi-conductive physics? One needs to look at that problem and look at the scientific possibilities and application areas and then broadly in the light of the needs of science and technology decide what needs to be done and then say: "Right, now who can finance this?" That look is a way scientists naturally think and, indeed, any practical person thinks, any industrialist. Should that not be represented in the way the expenditure is allocated?

(Dr Rees) Yes.

222. That you do not want a system where you have a decision by Government, where they say: "That is the science budget, how do you carve it up between medical, the environment and so on?"

(Dr Rees) That is exactly what happens now. That is how the AFRC and MRC are co-ordinating their work in genome research, for example.

(Professor Blundell) I wanted to make this point: we have mechanisms for collaboration between Research Councils to put forward programmes together. The genome research, immunology and the global environmental change proramme this year involve AFRC and other research councils; they are very successful. I believe it would be a mistake to argue for an overall strategic view in the form of a national Research Council. What we need is devolved responsibilities to the Research Councils of the kind we have with executive responsibility held in each of these Research Councils in place, and in addition a forum for discussion to establish broad collaborative objectives as we have in the regular meetings of Heads of Research Councils and ABRC.

Chairman

223. Would that be a view broadly shared amongst you?

(Dr Rees) Yes.

Dr Bray

224. That is not the proposition at all. There is a very strong case for a variety of Research Councils. You have different missions and you operate in different areas. What is at stake, however, is the way the Government looks at this and this very much goes on and says: "Right, there, William Waldegrave, is X hundred million for the science budget, go away and carve it up".

(Dr Rees) It is against a scientific case.

Dr Bray: It does not even get through to the Treasury.

Chairman: That is something to be pursued elsewhere.

Sir Trevor Skeet

225. Can I move you on to ACOST and get some clarification from you. Here the great and the good bring out very learned things which I dare say are read by many and influence scientific opinion, but do you not think the OST could contract certain specific matters out to other people and could not greater use be made of the Royal Society to put out papers on specific matters? I see we have a recommendation from the MRC who probably considers this a good idea.

(Dr Rees) Yes. My own view is that if we are looking for a body that will replace ACOST it should be more concerned with the strategic perspective and taking an overall view and less with picking off areas and writing reports on it. The Government is going to need those things and it should commission them from expert groups, if necessary in competition, to whoever is the most appropriate[1].

(Dr Hughes) I would not disagree with that. There is a role for a top level strategic body but the actual commissioning can be done in all sorts of ways.

(Professor Blundell) I was a member of ACOST before I took my present job with the AFRC. My view is it took too long carrying out the commissioning of research for reports. That could all be delegated very nicely to the Chief Scientific Advisor who could commission reports within the OST or from other bodies like the Royal Society or a number of other policy groups. The overarching policy group needs to be thinking about broad policies and a balance, not just detailed research projects.

Chairman: Can we turn to the question of Research Councils.

Mr Batiste

226. Turning to administrative structures in the Research Councils, two specific questions, first to Professor Knill. Of the five Research Councils the size of them varies enormously, you have got two that are larger and two that are smaller and you are in the middle of it. Do you see a vast differential in the size from one end of the scale to the other is causing Research Councils difficulties or is it of no consequence?

(Professor Knill) There is a factor which relates to the extent to which senior staff of the Research Councils, particularly the heads of the Research Councils, can be regarded as accessible to the community. I would regard the size of NERC as about right in the sense that I believe in accessability both to the higher education community and my own Research Council Community. If NERC was larger then I think it would be very difficult indeed to have that access and that is, I think, the main comment I would have. In terms of the whole mechanism of managing Research Councils, you can manage a Research Council that is twice or three times NERC's size but it is access that is the key issue.

227. That leads me to the second question for Dr Hughes in relation to SERC. I am told in your administrative structure you have on the Council Boards, Committees, Sub-Committees, Panels, Directorates and Advisory Groups. I know everything is very complicated and you are dealing with a very wide area but that seems extraordinary. Are you not in fact too big?

(Dr Hughes) I will take the first point first. Yes we have bodies called by all of those names, Chairman. Many of them are, as it were, specialist panels that are set up for specific purposes. The basic structure in our peer review system has four layers: the Council, Boards, Committees and Sub-Committees and the various other outfits you describe are either synonyms for elements within that layer structure or special ad hoc panels.

228. The point about access, personal access from your constituent community, do you feel with the size you have that is possible?

(Dr Hughes) It is more difficult with a larger organisation but I believe, speaking on his behalf, that my chairman is accessible to the wide range of the community we cover. Indeed we have a programme between three of us of visiting every HEI (there are about 80 or 90 of them) once every three years. So we do a great deal in that regard. The size though of course does make it more complex. It also brings with it some advantages of being able to cause interactions to happen which are sometimes easier within one organisation than with another. I think there is another factor for SERC, which is relevant to this say by comparison with NERC. As I said right at the beginning, SERC is essentially a funding body rather than a doer of research. So though we have a much larger budget a great deal more of it is

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[1] *Footnote by witness:* In many cases it will be the Royal Society.

[**Mr Batiste** *Contd*]

let out, under grants and other forms of support to HEIs, and our administrative system of our own staff is actually smaller than some of the other Councils.

229. Does that not tie in with the figures? My understanding is about 6.4 percent of your total budget is administrative costs and that does not include the man hours put in by the academic community for which they are not paid which must be enormous given the view of the constituent element in it. It seems to me your administrative costs purely for funding are actually rather high.

(Dr Hughes) The 6.4 percent includes some things which are actually centrally funded scientific activities like supercomputing. It does not though include their own time measure of academics who serve on peer review bodies.

230. It is significantly higher as a proportion than most of the other Research Councils which have smaller budgets and therefore you expect them in percentage terms to be higher?

(Dr Hughes) Which bit are you talking about?

231. The 6.4?

(Dr Hughes) I do not believe the 6.4 is. Certainly it is true our peer review system is much larger because we are dispersing a much larger budget over a much wider field.

(Professor Blundell) I think there are several factors which define the optimal size of Research Councils. One is accessibility of the Chief Executive, another is the coherence of the strategic science which it has responsibility for and the other is the strategic, financial and personnel planning. One needs to have a sufficient size to be able to have responsibility for moving people or initiating building programmes. My experience from being on the SERC and the AFRC Councils and from being involved in MRC programmes before my present job, is that there are definite advantages of having Research Councils like the NERC, MRC and AFRC. We should move to a pattern of mission-orientated Research Councils which are all doing some basic research; they are doing the same spectrum of science and they are of roughly similar size. That would be a great advantage to the administrative efficiency.

(Professor Newby) On behalf of the smallest of the Research Councils we suffer from genuine diseconomies of scale especially on this representational role. It is not just access to our own community, it is dealing with an element in the Community which might be regarded as customers for the research we sponsor. I have to deal with 15 Government Departments as well as the same number of universities everyone else has to deal with and that is where the diseconomies of scale do really bite. There are two ways, one is the size of our budget, it will always be the case because the social sciences will have a smaller budget than any other comparable Council, and the other is the size of the Community we represent and on that score one could look at this in quite a different way. It may be something the Committee will want to bear in mind if and when it discusses the notion of the Humanities Research Council.

Dr Bray

232. The Humanities Research Council is current but we are not inquiring into it. Can I ask you whether any of you in the normal course of the public expenditure round met anybody in an official capacity from the Treasury?

(Professor Blundell) No.

(Professor Newby) As a Research Council we have an inter-action with the Treasury which is rather different from all the others.

233. That is all research for the Treasury on a particular field?

(Professor Newby) Indeed, I have met with the Chief Economic Advisor on those issues.

234. Not on the overall ESRC budget?

(Professor Newby) No.

235. None of you met the Treasury?

(Professor Blundell) No.

236. On the question of dual support, the funding councils are still working out their system and they are proposing a system based on a different set of initials QR, DevR, JR and SR?

(Professor Davies) Not SR, SR has gone.

237. It is on its way out?

(Professor Davies) Gone.

238. Gone completely. On the quality of research, the universities' funding council had running a quality assessment, triennial assessment, is that what you mean by quality of research?

(Professor Davies) Yes. It is a funding methodology which is driven by the results of that research assessment exercise which is currently, the third one, in progress and the final information from it is due at the end of this month to go to the funding council at its meeting in early December for use in the funding round which will ensue in January and February of next year.

239. That is basically an historical look at what has been done in the past. It is not an assessment of what the research proposals are for the future?

(Professor Davies) Indeed, Project-related issues are the responsibility of the Research Councils. In fact, it is dominated indeed by historical information, although we have included this time in the third round a request from all the submitters for information on their strategic view forward but it is certainly dominated by recent achievement.

240. Where does that strategic view forward affect the research allocation?

[Dr Bray *Contd*]

(Professor Davies) There are two elements of it. It is reflected in the way in which the panels judging the quality of the submissions are influenced by the strategic vision. It does not influence the broad framework of distribution of funding allocations that the funding council itself makes. That broader view is influenced by a variety of inputs from our knowledge of what the Research Councils are doing, from our knowledge of what ACOST is doing, from our knowledge of the way in which the resource base has developed and it is a very dynamic resource base generated over recent years.

241. How much can a university expect this future research funding to depend on the quality of its forward look? How much will it depend on that formula?

(Professor Davies) It would be quite unrealistic to say it is anything other than a very minor influence.

242. Why does that happen? The Research Councils were bound to look at the quality of the proposals of future work. Within the universities surely the universities must be in the same position?

(Professor Davies) There are two different areas. There is the issue of institutions and the issue of the funding council. One of the requirements of the funding council is with the dual funding element that it recognises institutional autonomy. It seeks to identify the quality of the activity in institutions and then in a non-responsive mode it seeks to have those institutions develop strategies which are consistent with the proper use of the funding we allocate to them. We in our own strategic planning seek strategic advice from institutions on the shape of their intentions.

243. In terms of your own overall strategy, yes, but supposing what used to be called a polytechnic puts forward very lively teaching under community development, under research, under a basic research programme which is clearly well worth funding and it is not suitable for any Research Councils because the actual basic research element in it may be quite small, it may be very integrated with teaching and all that but it should be a major factor in the funding council allocation. Does the system accommodate that?

(Professor Davies) It will accommodate it much more easily because by dispersing in the end the funding for teaching and research as block allocations. Each individual institution can then examine its internal priorities and make those dispositions. Subsequently, we would seek within the framework of accountability to identify the use. If they identify one of those heterogenous priorities we would expect this to be reflected in the institutional funding.

(Dr Rees) We have not had a national science strategy before, and when we do I suggest that Research Councils and funding councils will have to take more joint interest in where individual institutions are going and the part they will play in that overall strategy. I referred before to the research environments and the importance of delivery against research missions. This leads us to need to which institutions are going to pick up which ball and run with it. Apart from the funding council, the MRC also has a need to relate to the Health Departments who do much to determine research environments in hopsitals and medical schools. For example, with the Tomlinson Reforms of London Hospitals we have to raise with the Department of Health what the changes will mean for our ability to do clinical research. I do hope we can move towards structures which will allow us to do that, similarly with funding councils.

(Professor Newby) I chaired the UFC's Northern Ireland Committee. The way in which the formula is translated into cash in the future will vary from the form of our funding councils now. [That information will be imparted, in my judgment, in the formal announcement being announced on Monday.] That variation will take account of some of the future orientated strategic research plans being submitted by universities. It is not entirely looking through the rear view mirror and the extent to which it is will vary from one part of the country to the other.

(Professor Davies) I wanted to reflect on the comments Dr Bray made. The type of proposal that you described in the round was one which integrated teaching and research in a complex way. The comment was made earlier there is a separation of teaching and research. It is true to say in the interests of accountability there is a separation of the funding streams for teaching and research, but because they then arrive in the institutions as block grant the institutions can bring together different forms of emphasis so, for instance, the academic staff who have a role both in teaching and research draw upon the income from the separate funding streams. This is a very important way in which you can integrate because of the duality of our part of the funding scheme. You can integrate teaching at undergraduate level and postgraduate level. Teaching is a link to building a research base through taught master programmes which feed research centres and the research schools. This is the way one would expect the institutions to exercise the judgments of which they are capable.

244. It is clear within the institutions there is the flexibility there.

(Professor Davies) Yes.

245. As between institutions or, if you like, in the overall allocations to an institution. From what you seem to say there is very much less flexibility.

(Professor Davies) I am sorry?

246. In the allocation of total funds to particular institutions there is very little flexibility in relation to the forward plans for institutions in the research area?

[**Dr Bray** *Contd*]

(Professor Davies) In terms of the way in which specific proposals that might be embodied in the strategic submissions to a research assessment exercise, that is correct.

Mrs Campbell

247. I want to explore this relationship between the Research Councils and the funding council. My first question is really specifically to Professor Davies: there were criticisms of liaison between Research Councils and the UFC even when they were both under the aegis of the Department of Education and Science. Now we have Research Councils doing OST's responsibilities, while the Higher Education Funding Councils report to the FE. You have mentioned already there is co-ordination but I would like you to be more specific about it and tell us how that happens, whether it is on a formal or informal level?

(Professor Davies) At the moment there are no formal structures that link us. There is a series of informal meetings from which we benefit so we can ensure we have a co- ordinated view. I meet with individual heads separately, as I meet with the Chairman of ABRC separately. We have adopted a policy whereby we seek to bring people in to the current research assessment exercise which we as a funding council are managing. It is being managed by a member of the staff of the Science and Engineering Council. I approached the Chairman to have him seconded to us so we can build our common purpose. It does depend very much upon the personal commitment of my officers and the officers of the Research Councils. These, I think, because of the current chemistry function very well. I can see advantages, as I said earlier, in having some more formal forum.

248. Do you see the relationship changing at all when and if the Government develops its strategic policy for science? Would you see your present informal structures either becoming formalised or changing in some such way?

(Professor Davies) The shift from DFE, or DES as it was, to OST had little impact in so far as our interactions before and after the April events were concerned. There is essentially no difference about various funding bodies. What has happened is it has made interactions of the kind my colleagues have discussed, and here I speak on behalf of the other Chief Executives of the Scottish and Welsh Council, and the interactions of the Chief Scientific Advisor more important. We have now set up a mechanism whereby we also meet in a systematic and regular way with him.

(Dr Rees) I think I should say that better integration is something we have always wanted but when we shared the same Department of Education and Science this was discouraged.

Chairman

249. We had better move on to other funding issues.

(Professor Davies) One small correction: there is one formal mechanism in the way we act as a funding council, I am an assessor on three of the Research Councils and I have another assessor of one of the others, so we have that formal linkage. The current Chairman of ABRC is a member of the funding council.

Mr Strang

250. May I ask Professor Blundell and Dr Rees about the carrying out of the work by the Research Councils for their respective departments on a customer contractor basis. What is your view of that system? Does it cause particular problems for you? Have you any suggestions to make about it?

(Professor Blundell) First, I should say that the carrying out of the research for Departments like the Ministry of Agriculture, Department of the Environment, Department of Health, is a very important part of the Research Council's activities, certainly for AFRC's activities. Could I make the point, however, that those activities are not linked to only one Department, and we need to retain a situation where we carry out contracts for a number of different Departments. I think that is a very important point. The problem, of course, that has arisen in the Research Councils over the past years is that the work coming from MAFF, as customer, used to have a very long term strategic view. It has now become a much more short term contractor arrangement. Furthermore, the role of the proxy customer within MAFF has moved from the Chief Scientist's Group to the policy heads. So the scientists within the Ministry have a less important role and the policy makers an increased role. These two factors, the making of more policy and making contracts more short term, do create tremendous problems if policies change rather quickly. You will be aware, and I am certainly aware as Chief Executive of the Council that has had to do this, that if we have to make people redundant we have to do it at greater cost over one year than keeping them employed. Therefore, the mapping of the shorter term objectives of the contractors on to the longer term strategic objectives of the Councils, and the longer term planning requirements of staff and facilities, does pose a problem. We have some way to go with all the different customer departments, Government Departments, to get a longer term strategic arrangement and understanding of our mechanisms and requirements for operation.

(Dr Rees) We have a very different arrangement indeed. First of all, it is very important to have a healthy and effective customer contractor relationship between ourselves and the Department of Health and indeed with other Government Departments. Post Rothschild, however, we—both the Department of Health and ourselves—recognised that the purchase of a research item is not quite

[Mr Strang *Contd*]

the same as walking into a supermarket and deciding which brand of cornflakes you are going to purchase. Often an important problem might not be amenable to research today and we can do more than research the underlying phenomena in the hope of finding clues. Sometimes there is the research possibility which will deliver against needs which the customer has not yet recognised he has. So the customer contractor relationship has had to develope within the kind of strategic alignment which allows us constantly to be talking about where science is going, what it might deliver, when it is timely to visit old problems. For example, recognising that mental illness is the major single burden on the National Health Service, the NHS carried out a study of the most important issues for improvement of the cost effectiveness of the treatment. They have come up with a list of priorities for some of which we will take responsibility. We are funded to do this through the reverse transfer of Rothschild money. The arrangements are enshrined in what we call a Concordant, through which we oblige ourselves to engage in this process, as monitored by appropriate performance indicators. This is the first year. It ran for a five year period, we reviewed it, improved it and tightened it up, it has been running for a year since then and the MRC is I believe, happy with it. You must ask the Department of Health but I have reason to believe they are happy with it too. It is a concept we are trying to extend to the Overseas Development Agencies over and above the research in relation to aid issues. In addition to that with the Department of Health, if they come along with odd jobbing requests for us to do things which are not a natural part of our portfolio remit but because of our ability to commission and evaluate research then we will do that and they will give us extra money for that. I think it is a very good situation and I commend it to other Research Councils and Government Departments.

Mr Williams

251. I would like to ask Dr Rees specifically about the Health Service, the threats to research workers there. The NHS changes, the establishment of Trusts, means every hospital is working in a much more autonomous fashion and to Chief Executives and their Boards, research workers, their primary role is treating patients. Do you accept there is a threat to the research work being carried out, Sir, by our hospitals and does the MRC or the Office of Science and Technology have a role in safeguarding the research work that at present comes from the Department of Health budget?

(Dr Rees) This is a very real issue but I would say it is something I am very conscious of, the difficulty of solving the problem, more so than actually feeling alarmed that research is necessarily going to suffer. Ever since the Health Service Reforms were introduced it has been acknowledged on all sides that knock on effects for research and also for teaching need to be taken into account. The whole aim of the Health Service reforms is to improve accountability and financial transparency. This should make it possible to identify that money which is intended for research and make sure it is used for research. A problem at the moment is that, even within the Health Service there are competing research claims for that money and there probably is not enough of it. We are particularly concerned that money be provided for the infrastructure costs associated with MRC clinical research through the mechanism known as SIFTR. Another need is for the NHS to develop its own research programme, requiring a separate fund. Problem number one is to make sure that that money which is meant for research is used for research of whatever type. Secondly, that there is the correct balance between the use of that money for the infrastructure for research MRC commissions, and that the NHS does itself. Thirdly that there is enough money to do what is needed.

Chairman: I am conscious gentlemen the second hour is just about up but we do have two or three more questions which possibly can be answered relatively briefly if they are asked relatively briefly. Can we turn to the small matter of international facilities?

Sir Trevor Skeet

252. Dr Hughes, I have read your excellent report of the programme which looks ahead and I have noticed from the table there that you spend annually on particle physics, radiation facilities, space and astronomy £133 million a year which is 25% of your total expenditure of which a certain part of that goes on foreign exchange. That is being borne on foreign exchange and the recent devaluation has made it even worse. It has not been spent on science. Do you not think the Treasury should be accountable for any deviation here?

(Dr Hughes) In one word, Chairman, yes.

253. Thank you very much for that answer which I anticipated. Now as other countries in Europe are engaged in CERN and in space, how do they tackle their own arrangements? The Italians I understand do it through the Foreign Office, what happens in Germany, what happens in France?

(Dr Hughes) It varies considerably between countries but by and large the systems in other countries are such that the subscriptions are paid more centrally than they are here. Our view, which we have thought about very carefully over the years and over the last few years in particular, is that we would not advocate that everything is accepted lock, stock and barrel say by the Treasury or by the FCO, because the object of these subscriptions actually is to secure access to scientific facilities. The purpose of spending the money is for carrying out science. I would take issue slightly with the part of your question which suggested, I think, that it was not anything to do with science. It is all to do with

[Sir Trevor Skeet *Contd*]

science and we believe therefore that the purpose for which these subscriptions are intended should be seen and looked at by those bodies that are concerned with science. However, most of the subscriptions are treaties that have been entered into by Government or in some cases by SERC acting as an agent of Government. Where there are factors which are outside our control that assist in setting the cost of the subscription, such as exchange rates what we would advocate is that there is some system whereby the factors outside our control are covered and we do not have to cover those by penalising other areas of our portfolio.

254. Outside your control but inside your pocket?

(Dr Hughes) At present they are, yes.

255. May I ask you for the figure you will have to contribute annually on the basis of the 10% devaluation recently that you would have to pay, that you would not have to pay if some other Department took it over?

(Dr Hughes) I have to put a caveat on the answer: it is a complicated sum and varies by the day, but it is of the order of £10 million next financial year.

256. Finally, for France and Germany what are their responsibilities on this? Are they spared this?

(Dr Hughes) They will have to cover the effects of this and whatever has happened to their currencies. Part of the complication I have just mentioned is that the way the the cost of the international institutions, for example CERN or the European Space Agency, is divided between the member nations is based on factors that relate to net national income, and therefore GDP. There is annually a rather complicated sum that will affect not only us but the other partners. I believe the falling pound will have a larger effect on us than any other participants.

257. It is not exactly a level playing field.

(Dr Hughes) No.

(Dr Rees) Very quickly, I think it is relevant to Dr Bray's last point. We are involved in a much more minor way with the European Molecular Biology Laboratory and the International Agency for Cancer Research. I think it is a real shame, and something we should alter, that the UK has got itself into a situation in which we have so much investment in scientific infrastructure in other countries without stirring ourselves to get *quid pro quo* with other countries to invest in UK research infrastructures.

Mrs Campbell

258. Presumably you did set your budget on the basis we would still be members of the ERM and that would provide a much more stable financial climate for you in which to work. Would you like to give some advice to the Government? What advice do you think we should give to the Government about this, particularly as it affects scientific funding?

(Dr Hughes) The first part of that statement is correct. We set our budgets with appropriate contingencies on forward estimates of exchange rates and set our contingencies with respect to the limits of the ERM so from our point of view the system, coming out of the ERM, has had the large effect we certainly do not welcome.

Chairman: Can we turn to another aspect of European research.

Cheryl Gillan

259. Europe seems to be very topical at the moment. I think that you would probably all agree we are levelling the playing field in Europe by putting science and technology at the level of a Cabinet Minister and this is certainly going to improve our standing in Europe and our position when we are negotiating with our friends and colleagues within the European Community. There is a common theme running throughout many of the papers I have been reading and in connection with this investigation which shows everything in the garden is not rosy as far as our interface on the European side is concerned. I would particularly like to address a very simple question as to how the Government could bring about better correlation between the policies of DGXII in Brussels and UK institutions such as yourselves?

(Dr Rees) I think the Minister has made a good start actually. He has had a number of meetings with Mr Pandolfi. I am actually a member of the Committee for the Development of Science and Technology in Europe which is DGXIIs Scientific Advisory Committee and I try and keep my colleagues involved and informed about what is going on. I have to say that before we had a Minister for Science, it was very difficult for me to relate my responsibilities to what was happening at the higher policy level. Now, with a single Minister responsible, there has been a really dramatic improvement there. There are, of course, divided objectives. From the way you phrase your question you seem to think as I think that the European Science Programme should be developed in a way that actually improves European Science contributions to R&D and technology. The Commission has a separate agenda which is to use scientific research programmes as a glue to stick the bits of Europe together, to keep the Southern countries on board, and so forth. Sometimes that can blur scientific assessments or even make the scientific considerations actually secondary to the political agenda. From that point of view it is important I think that the countries with a concern for scientific performance, by which I mean France, Germany and ourselves, get together at ministerial level to press this. From where I sit I see real signs that we are now beginning to get

[Cheryl Gillan *Contd*]

together a common line which is steering the Commission more in the direction that we would like to see.

Chairman

260. That is very helpful to hear.

(Professor Newby) To follow that up, I think it is fair to say we are all concerned about the quality control of European programmes, perhaps the lack of it. We are all concerned about the management arrangements or the absence of them and we are all concerned about the evaluation procedures or again the absence of them. I think it is important to underline that for us international collaboration is a means not an end, it is a means to improve the quality of science. Therefore, we are not interested in the lowest common denominator research but we are interested in research which will actually improve the quality of science. We all feel there is some way to go in that regard as far as the European Community is concerned.

(Professor Knill) There is a factor at the other end of the spectrum, that is to say the individual scientist must lobby in Brussels far more than he would expect to lobby in the United Kingdom for the science. Therefore, the influence the scientists have and the development of framework programmes as they evolve is particularly important in this and I think that message fails to get across.

Cheryl Gillan

261. Do you think the framework programmes and our own schemes should be more integrated and complementary than they are at present? I am worried about the structural transfer to OST and the possible loss of co-ordination between OST and the DTI. DO you see that as a likely outcome and how can we safeguard against that?

(Professor Knill) There is a crack between the two. This is one of the roles for the Minister to see that crack being sealed.

(Dr Rees) If there were indeed a crack between OST and DTI, the OST would not be doing its job because its job is to seal things together. I do agree with you that if our national scientific strategic project could be extensively related or considered or developed within the context of some European strategy, or European development which took that into account then that would be great. But again, the Commission is ideologically opposed to that. It believes it is there to do its own thing, to develop its own programme separately.

Sir Trevor Skeet

262. You believe in the principle of subsidiarity?

(Dr Rees) That is right.

(Professor Davies) Could I pick up one point in the European context. Increasingly, higher education institutions have been aggressive in seeking their proper share of contractual availabilities in Europe but our institutions repeatedly complain of one particular disadvantage which I do wish this Committee would take on board, and that is that the indirect cost element is capped at 20% which is recognised to be a real shortfall in other Community countries. It is a shortfall between what might be identified as more appropriate indirect costs of the Research Councils which use 40%, which is not made up from other Government sources. This is not the case for the higher education institutions here so they are disadvantaged in taking on a number of European contracts because they have to divert other resources. If this can be handled in a way whereby there is proper compensation through a complementary supplementary funding stream it would be of great merit and of great advantage to the higher education institutions.

(Dr Rees) We have to change the Commission, not subsidise it.

Mr Batiste

263. Just on Trevor Skeet's point, he mentioned the word subsidiarity in the context of science. From what I gather from what you are saying were there to be a recognition of something like subsidiarity principles in respect of science you would expect a significant repatriation of activity which is done at the moment by the Community. Is that a correct understanding?

(Dr Hughes) There are elements of programmes the Commission is conducting at the present and which it proposes in framework four[1], that we would not consider fully satisfy the subsidiarity criteria.

(Dr Rees) The attribution at the moment is rather small so I think repatriation may not actually be as important an issue as changing the system, so it does not develop into something which is a real cuckoo in the science nest.

Chairman: We now come to the last question, if we may, which is about peer review.

Mr Williams

264. Could I ask Dr Hughes how do you streamline the peer review system? I understand because of the shortage of funds the system is swamped? I was told yesterday by one of your sub-committees there were 107 applications, lots of intellectual energy going through those and only six were accepted eventually. In Sir Peter Day's submission from the Royal Institution, he suggests each principal investigator should only hold one grant at any one moment in time.

(Dr Hughes) That is one option we are currently considering but I think I have to say it is one which is not generally favoured. We are looking at other options too. We have to try to find a way across the tightrope between accepting that excellence requires competition amongst the proposals that we are

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[1] *Note by Witness:* This means "Framework Programme 4".

[**Mr Williams** *Contd*]

going to receive and that this is bound to mean there will be many who fail. Therefore we want to see academics putting forward good proposals and see that the competition judged by peer review is strong competition. That means you do want to see a good field coming in. We have to balance that with being swamped. Our feeling at the moment is that we are somewhat swamped. There is undoubtedly a large element of administration involved in dealing with the very large number of applications we get and we are looking at various ways of trying to deal with that. The one which was the favourite that has just been made as a recommendation to the Council is that we do more to feed back to individual HEIs statistics about the success rates and failure rates of proposals they have put in, in an attempt to try to get some improved feedback on the quality of incoming applications. At the same time we aim to do rather more to eliminate from the process those that are clearly not going to get anywhere.

Dr Bray

265. Is there a tendency in the SERC for the official structure to cover itself by needing an over-elaborate peer group structure in referring particular issues to it? Would it, for instance, be possible to limit each principal investigator to hold only one grant as suggested by Professor Sir Peter Day of the Royal Institution?

(Dr Hughes) I have just explained that a kind of quota system is something we generally do not favour for various reasons, but I would tend to agree with the sentiment of your point at the beginning, that our peer review system in a sense has grown in a way where, on some issues, it tends to be used in ways beyond that for which it was originally intended. That is something we are also addressing.

Chairman

266. You are looking at that?

(Professor Newby) I think it would be important for the Committee to understand the legitimacy of the money of the Research Councils, the operations of Research Councils that is, does rest very strongly on the quality of our peer review process. Earlier in the discussion this morning reference was made to the distance that may exist between the Communities and ourselves. There is no doubt one of the bits of glue which does bind us together is the peer review process. If we depart too much from that we risk damaging that relationship. It is a very difficult balancing act. I personally would resist the word swamped which rather implies one cannot cope. All Research Councils have seen a considerable increase in applications in recent years. There are many incentives operating to encourage researchers to submit applications to Research Councils as opposed to other sources of funding.

(Dr Hughes) I would support that wholeheartedly. We see no alternative to peer review. What I have been talking about in the last answer was really about trying to improve our machinery for peer review.

(Dr Rees) Can I say, however, I agree with what my colleagues said. The Micawber principle does operate: the less money you have the more energy you have to expend in deciding how to spend it best. Coming back to Howard's point, if we do have a sharp reduction in forward budget projections the peer review of project grant applications is going to involve a great deal of the agony and that will have a knock on effect on administration.

(Professor Blundell) A comment about peer review: there is a large part of Government science research funding outside the the science vote that we are responsible for. I am conscious that those areas of Government science are very well merit reviewed. I wonder whether peer review is not more appropriate in a broader area to get good quality facilities and, good quality staff. I think peer review needs to be extended, certainly not contracted.

Chairman: Thank you very much Professor Blundell, Professor Newby, Professor Knill, Dr Hughes, Dr Rees and Professor Davies. Thank you all very much for your time which has been considerable, your capacity to handle the questions is equally considerable and for the information and important suggestions you have made to us. We are most grateful to you individually and to the Councils you represent. Thank you very much indeed.

THURSDAY 12 NOVEMBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mrs Anne Campbell
Cheryl Gillan
Mr Andrew Miller
Mr William Powell
Sir Trevor Skeet
Sir Gerard Vaughan
Mr Alan W Williams

Memorandum submitted by the Chemical Industries Association (16 October 1992)

The UK chemical industry invests a greater proportion of its own money in research and development than any other sector of manufacturing industry—approximately 7 per cent of total revenue. As UK manufacturing industry's number one export earner, making a positive contribution of approximately £3 billion to the balance of trade in 1991, the chemical industry has a demonstrable record of success in turning research into wealth-creating products and processes.

Innovation can be described as the successful exploitation of inventions. The main role of the Office of Science and Technology (OST) is to ensure that research and development resources, including funding and the related management structures, are in place to maximise the benefit to UK industry; an important element of this is the provision of appropriately trained people for industry and for academia so that a quality science base can be maintained. This means adopting a funding policy which takes account of the needs of industry and acts in support of it, recognising the significance of a healthy science base to the creation of wealth in the UK. We strongly believe that government, through the OST and the Research Councils, has responsibility for ensuring that adequate provision is made for a sustained research effort in areas of fundamental science which underpin industrial activity. There should be a symbiosis between market-driven and "blue sky" research: industry leads the former and the academic sector should concentrate on leading the latter, with a healthy interchange of knowledge and expertise at the interface.

It is our firm belief that the problem in turning research results into wealth-creating technologies does not lie in a lack of new ideas: the problem lies in the capability of the UK manufacturing sector to exploit advances in knowledge and turn them into value-added products and processes. The UK has a strong and well regarded science base, but we cannot hope to succeed if advances in research have to be exploited abroad.

It would, however, be wrong to be complacent about the strength of the UK science base. Concerns are emerging that investment in capital equipment is inadequate, that there is insufficient consistency in funding and that patterns of funding do not adequately reflect industrial requirements.

We believe that, as a result of the White Paper consultation process, the government must adopt a clear and consistent strategy for its funding of public sector research. We do not wish the government to fund activities that should be funded by the industrial sector, but we believe that funds should be strategically deployed to provide basic research support in areas which can be exploited.

A particular area of concern is that research fields of strategic importance to the chemical industry are not being adequately funded.

When a science and technology strategy has been adopted, it will be appropriate to consider what advisory structures are required by the government. It may be that the newly established OST and existing bodies such as ACOST and ABRC are adequate vehicles, but a prime requirement will be access to authoritative advice from those involved in industrial research and technological development.

The DTI's main role is in support of the industrial exploitation of good ideas. This means working with industry to create a favourable climate for innovation through legislation (ensuring adequate protection for intellectual property, for example) and through the promotion of industrial research links and technology transfer. Through initiatives such as the LINK scheme and the proposed Faraday Institutes, the DTI has an active role in developing effective liaison between the industrial and academic sectors. The DTI must also work to ensure that investment in science and technology at a European level, through the EC Framework Programme, is based on a sound understanding of industrial needs and hence economic relevance. This is also true for legislative and regulatory considerations.

The Department for Education has a role of fundamental importance in the innovation process. Technology-based industries such as chemicals are critically dependent on a well-educated workforce, both at graduate and non-graduate level: the importance of adequate funding for science education and the maintenance of high academic standards cannot be emphasised too strongly.

In all these activities, effective communication between OST, the DTI and the Department for Education is vital, but a common strategy must first be established and understood if the right policies and organisational structures are to be achieved. We hope that this strategy will emerge from government as a result of the White Paper on science and technology, and our detailed comments on what we believe it should be will be given in our comprehensive response to Mr Waldegrave. We would like to stress, however, that any such strategy must necessarily be long term and will require a more consistent approach by government departments than has been the case to date.

Memorandum submitted by the Engineering Employers Federation (4 November 1992)

Some Engineering "Bull Points"

1. *The roles of science and engineering in wealth creation*

In the list of questions identified by William Waldegrave, although there are appropriate references to "science and technology", the word "engineer" appears only once—and at the very end. Whilst excellence in science will continue to give the UK acclaim within academia—and may win us some Nobel prizes—only if it also results in the development of inventions which can be sold in the market place will it succeed in creating wealth for "UK Ltd".

Engineers are actually the "scientists" who develop and design the technologies and manufacture the products essential for wealth creation. The Victorians knew this well enough, but the present government has lost sight of it and for too long has worked on a misguided assumption that the service and finance sectors can be relied upon to "deliver the goods".

2. *Need for an industrial strategy*

EFF is concerned that the Government has no clear strategy for securing and developing the UK's essential manufacturing base and for keeping the optimum number of people gainfully employed. It therefore intends to present its own strategy for industrial recovery to the Government before the end of this month.

3. *Separate budgets for science and engineering*

In its future budgets for science and technology, the government needs to differentiate clearly between pure science and its subsequent application via engineering and manufacturing. Selective funding should be available to secure the development of those technologies and products which are of strategic importance to the economy and in keeping the UK abreast of international competition. Key sectors and skills should not be allowed to wither on the vine through short term market forces and the lack of a strategic overview from government.

4. *Comparable support with competitor countries*

It is not clear how much the UK actually spends in supporting those R&D programmes which are "near to the market place" as opposed to other "pre-competitive research", but one suspects it is considerably less than in major competitor countries. The Government ought to make a detailed study of how Germany, Japan, France and the USA support R&D for their own strategic industries and technologies—and the proportion of the GNP spent in each case.

5. *Nationally strategic technologies*

The government needs to decide and define what those strategic technologies are for the UK and then allocate funding for the whole cycle from research and innovation, through demonstration and development, to production. A MITI type committee, with sufficient industrial members, could be used to steer and monitor this. Individual companies would of course be relative winners and losers in this process —but the overall winner would be UK Ltd.

6. *Allocate responsibility to government departments*

Much firmer direction for government departments is required in the role they should play in supporting industry. For example, the MoD has extensive procurement and research funds, but no responsibility for industrial innovation; whilst the DTI, with responsibility for the latter, has relatively little funding.

7. *Tax concessions*

The UK is unique in being the only major industrial nation whose public investment in R&D decreased during the 1980's. Government's assumption that its own cut-backs would be fully compensated by greater spending by industry has not been realised. If more companies were more profitable, spending might arguably increase. If this is what the government believes, the introduction of tax allowances could help to reverse the trend.

Investment in the early stages of technological research is of continuing importance but it is the final development of strategic technologies which have moved closer to the market place and are potential money winners where more support needed.

8. *UK should support collaborative projects from exchequer and not EC funding*

International collaborative programmes, like those in the EC, should stem from a primary and comprehensive national programme for the UK. They should be an extension of our own national effort: not a substitute. HMG should fund collaborative programmes directly and internally for the UK and not delegate this responsibility to the EC. Some UK companies are deterred from EC collaborative projects by the sheer bureaucracy and time involved in seeking entry, as well as by social requirements like having to team with "Greek Polytechnics". Such methods of collaboration are often negated by confidentiality considerations, so this method of funding is quite inappropriate for innovation programmes.

8. *The contributions made by engineering*

The UK is an industrially dependent nation which has lost sight of its former industrial culture and heritage. Particularly it fails to appreciate the focal contributions made by engineers and engineering in designing and producing the technology on which all other sectors—including service and banking—depend as well as providing all the artefacts and infrastructure essential for civilised living.

The media tends to call such people "scientists", reserving the term engineer for the people who service your washing machine or mend your car. Engineers themselves accept they have a responsibility to try and dispel these misconceptions; but government and academia also have a central role to play in changing false public perspectives.

9. *Education's perceptions of engineering and industry*

A major national shortcoming is the inverted values generated within our own universities and technical educational systems. In most other West European countries, including France and Germany, the professional and social standing of engineers is on a par with accountants, lawyers and doctors. This is the result of a fiercely competitive, meritocratic, technological education and training system which produces an intelligent, articulate and broadly educated elite who are expected and encouraged to take their rightful place in industry and for whom employers fight to recruit.

10. *Promoting a culture change*

We suggest the Office of Science and Technology makes a serious assessment of the contributions made by the German Hochschuler and the French Grandes Ecoles and then lends its efforts and resources to changing our own cultures and priorities from the top down!

Consultation on Science and Technology White Paper: Questions on which the Government has requested comments

1. *Why does the UK seem to be less successful than its competitors in translating inventions to the market place? Why is this more so in some industries than others?*

UK effort is concentrated excessively on "research" rather than "development". While excellence in science wins academic acclaim and helps preserve a scientific infrastructure (the "science base"), it does not provide economic benefit unless it is developed for large-scale commercial exploitation.

Research is only the first stage of a long innovation process, which includes the equally important challenges of technology demonstration and development, production and marketing. The cost increases significantly with each stage, as therefore does the financial risk of failure. As markets are competitive, time can become critical in the later stages—requiring very large expenditures in a relatively short time frame to bring the product to market before the competition.

However, innovation is not merely a linear process moving from research through to market. It also involves the incremental development and improvement of existing products and processes. The British culture emphasises invention by individuals of completely new concepts derived from basic principles. Too little effort is put into application and execution. There is reluctance to adopt and improve on ideas generated elsewhere. Other cultures, for example the Japanese and German, are more concerned with the refinement of existing technology—indigenous and imported—by collective activity.

In consequence, the more complex the process of bringing an invention to the market, the less likely it is to succeed in the UK. Professor Michael Porter and others have stressed the importance of "clusters of excellence" for industrial success. The UK's over-concentration on initial research and individuality has made it more difficult to establish such clusters.

The short-term performance expectations of the UK financial markets can make it difficult to justify the long-term investment required to take an innovation through to commercial success.

Factors which can reduce the risk of the development investment include pricing agreements, protected markets, public procurement and launch aid. The lack of funding from all government bodies for developments other than those classified as pre-competitive research is making it more difficult for companies to bring engineering innovations to the market. The Government's "hands off" approach to investment in manufacturing is very different from competitor countries.

Accumulated expertise and cohesive teams are too easily lost at the bottom of the economic cycle and through swings in public policy.

2. *Do we have an agreed measure of the capacity of an industry, or a firm, to innovate? Do we really know whether our firms are getting better or worse at innovation? Do technology-based innovative firms survive longer? Is the alleged lack of innovation a lack of good ideas, or finance, or what?*

There can be no single measure of capacity to innovate. Market shares and the growth and range of profitable products and processes might be possible indicators. On this basis, the British engineering industry is visibly contracting.

Technology-based firms only survive in the engineering industry if their innovation is directed towards satisfying the customer and the development is followed through to the market. This can require vast resources.

Money is far shorter than ideas (see question 1 above).

3. *Do we need more or less planning in Government science and technology?*

The UK needs a more open, analytical and structured approach to planning in science and technology, as part of a national industrial strategy, towards which government and its agencies, academia and industry can work. This inquiry is a step in the right direction. It is encouraging that the Chancellor has said that economic policy options will be examined with a view to how well they support industry, help confidence and get the economy going. Government policy and planning should be based on an analysis of the long-term potential needs of its customers—industry as well as consumers.

We certainly need a different, more focused approach than in the past. It is not feasible to pursue every promising science or technology, nor is it possible to make perfectly optimised decisions about which is the most promising. In practice, it is usually better to develop something workable through to commercial exploitation than to continually switch support to other fields before the previous ones have born fruit.

4. *Do we get optimum benefit from our international collaborative programmes, especially in the European Community, and do they complement our national programmes well?*

International collaboration can be very valuable in so far that it can spread risk; facilitate projects which the UK alone cannot fund; provide a broader knowledge base to work from; and increase the chances of creating European and international standards. But these are possible long-term benefits. We do not get optimum benefit from international collaborative programmes for various reasons inherent in their design and organisation. These include bureaucracy, slowness and delay; the incumbrance of less technologically developed partners; and the danger of inadvertently sharing proprietary technology.

UK collaboration in international programmes ought to complement national programmes, within an over-arching strategy. They cannot be a substitute for national programmes, as they appear to be regarded by the present government.

5. *Does the UK get the very best value for money from Government's considerable expenditure on science and technology?*

We doubt that the Government is spending taxpayers' funds in the best areas or getting the best value for money. The scale of Government investment in the science base may look reasonable by international standards, but the problem lies in its failure to invest in closer-to-market applied research, technology demonstrators and product development.

UK expenditure may be large in absolute terms, but not relative to GNP, compared with other leading industrial nations, e.g., Germany, Japan and the USA. The UK alone has decreased its public investment in R&D during the 1980s.

Separation of responsibility for public expenditure and policy development between different Government departments and agencies is likely to militate against efficiency and effectiveness, especially in the absence of an over-arching strategy. Public purchasers should have some responsibility for securing the indigeneous industrial base, as in other countries.

The OST, perhaps in conjunction with the DTI's competitiveness unit, might study how France, Germany Japan and the USA have supported various areas of industry over the past 20 years.

6. *Are spending priorities right or would the Government be better advised to spend money in other areas of science and technology than the ones it funds at present?*

Since the process of determining priorities is questionable, the outcome must be suspect. HMG policy still seems to emphasise science rather than technology. It is time to give the latter priority.

Greater priority for funding should be given to national projects and industry-only collaboration.

7. *Does the Government have the right advisory structures at its centre to help it take decisions on priorities?*

The traditional approach to the advisory structure has been to emphasise independence and scientific expertise. This is not well matched to concerns about economic performance, exploitation of science and application of technology. Even at the risk of some loss of independent judgment, industrialists who drive the results of research through to commercial success must be represented to a greater extent in the decision-making.

To ensure adequate attention to engineering, relative to pure science, it may be necessary to have separate advisory structures and separate budgets for each.

The current process of allocating funds for research can result in institutions valued by industry being penalised.

8. *How can we best ensure that the strong upward trend in industrial R&D expenditure in the UK will continue and gather pace in the years to come, so that our record is as good as the rest of our international competitors?*

Industry will only invest if it is confident that it can afford long-term R&D.

Confidence could be improved by financial incentives, such as more tax relief, investment grants and government research and development contracts. Government could also encourage the upward trend by encouraging an analytical approach to satisfying customers by improving the product, however humble.

The increased industrial expenditure on R&D is being directed at near-market applications, in a possibly vain attempt to compensate for withdrawal of public funding. This may prove to be a manifestation of short-termism. If the economy does not recover soon, even this kind of R&D spending may be impossible to sustain.

9. *Could the links between academia and industry be improved to encourage maximum exploitation of the science base?*

Increased mobility between academia and industry is probably the most important means of re-orienting engineering education. We understand that German engineering academics have to spend every seventh year in industry.

The recent requirement for academia to move towards self-financing/profit-making programmes is resulting in a tendency for academics to be far more proactive in exploiting the science base. But commercialism is bringing with it short-termism and making universities charge "full overhead costs" to industry does not encourage industry to forge links.

Universities should be supporting industrial wealth creation, rather than seeking support from industry. Smaller companies especially need helping to identify and understand innovations which could be relevant to their business.

10. *Is the UK working in areas of basic science which have less marketable derivates than those on which our international competitors concentrate their efforts?*

The EEF's chief concern is the UK's over-emphasis on basic science at the expense of development, technology and engineering.

11. *Is there scope for improved training opportunities in science and technology?*

The cultural problem identified in the response to question 1 is perpetuated by the value system in higher education. University technical education in the UK promotes a spirit of innovation, but such innovation tends to be unfocused and misdirected. Other European countries' technological education and training systems are competitive, meritocratic and highly orientated towards industrial employment. Perhaps the OST should commission a study of at least the French and German engineering higher education systems and their contribution to manufacturing success.

There is considerable scope for improved training in science and technology, particularly in the area of exploiting technology to make money. However, engineers cannot be developed within academia alone; the essential complementary training and experience in industry must be subsidised.

We welcome the Government's efforts to further improve links between academia and industry through the LINK scheme, Faraday Centres, etc., but we believe that more funding is necessary; industrial involvement needs to be made more attractive; and industry's influence on the schemes increased.

12. *What steps do we need to take to improve the status of scientists and engineers?*

This question cannot be addressed in a vacuum. The primary task is to make British industry more successful.

Part of a letter to the Clerk of the Committee from Dr J P Griffin, Director, ABPI (22 October 1992)

In the meantime members of the Committee may wish to note the enclosed report "Supporting the Science Base" published by the Association as this year's "Agenda for Health".[1]

The members of the Committee will note from the report the highly innovative and successful nature of the UK pharmaceutical industry. We would like to remind the Committee that:

- In the first eight months of this year pharmaceutical exports reached an all-time record level of £1,900 million to provide a "surplus" over imports of £860 million—up nearly 15 per cent compared with the first eight months of 1991.
- Of the top 10 best selling medicines worldwide last year, no less than four were discovered and developed by British research-based pharmaceutical companies.
- The industry employs nearly 88,000 people directly and provides jobs for up to 250,000 indirectly. Of those employed directly over 18,000 are scientists involved in innovative medicines research.
- Spending on UK pharmaceutical research and development this year will exceed £1.3 billion representing nearly 18 per cent of total turnover compared with two per cent for the rest of manufacturing industry.

This success is partly based on the continuing provision of an adequate infrastructure for the maintenance of scientific research in academia. We therefore welcome the creation of the Office of Science and Technology particularly if it can achieve an effective co-ordination role of Government research and development policies. The Committee's efforts towards achieving these policy objectives are therefore to be welcomed.

We do note that the Committee will be seeking views from a spectrum of industries. We believe it essential that the Office of Science and Technology and the Science and Technology Committee appreciate the significant difference between the needs of the various industry sectors in the UK. For this reason, although we will be pleased to comply with the Committee's logistical needs and to participate with the other industry sectors in giving oral evidence, we do feel it unlikely that there will be broad consensus on the answers given.

Memorandum submitted by the Association of British Pharmaceutical Industry (10 November 1992)

1. The Association of the British Pharmaceutical Industry

The Association of the British Pharmaceutical Industry (ABPI) is the trade association representing 111 companies, the great majority of pharmaceutical companies in the United Kingdom who are engaged in discovering, developing and manufacturing prescription medicines. ABPI member companies supply more than 95 per cent of the medicines used in the National Health Service annually.

The main functions of the Association are:

- To maintain and improve the reputation of the industry and its contribution to the health and economic welfare of the nation.
- To assist contact between member companies and with government departments, professional, scientific and trade organisations, higher education institutions (HEIs) and other similar bodies.
- To act as a channel for communication and to act on collective decisions taken by its members.

The British pharmaceutical industry has consistently been one of the most successful sectors of industry in the UK over the last 40 years and is considered to be one of the most innovative industries in the UK. Four of the 10 top-selling medicines in the world are the discoveries of UK-based companies.

In 1991 it contributed £1.2 billion to the UK's balance of trade, and its combined exports exceeded £2.5 billion.

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[1] Not printed.

2. A RESEARCH-BASED INDUSTRY

The pharmaceutical industry is an internationally-based industry, and in addition to British companies many of the companies established in the UK are from the rest of Europe, the USA and Japan. An important factor contributing to the willingness of transnational companies to go on increasing their investment in pharmaceutical and biomedical research in the UK has been the high quality of research carried out in its universities, research institutes and medical schools, and the availability of well-trained, innovative scientists emerging from British universities. The UK pharmaceutical industry employed a record total of 87,000 people in 1990. This figure represents a 23 per cent rise in full time employment since 1970, contrasting sharply with a 40 per cent reduction in manpower in manufacturing industry as a whole. Nearly two-thirds of the increase in the pharmaceutical workforce reported over the last 20 years has been a result of the rapid expansion of Research and Development (R&D) personnel employed. More than 18,000 people are currently involved in the industry's R&D with a high percentage of them being scientists and engineers.

The pharmaceutical industry spends a considerable amount on R&D in-house. In 1991 this was over £1,200 million, representing approximately 18 per cent of sales.

3. LIAISON WITH ACADEMIA

In addition to the amount spent in-house the pharmaceutical industry has been giving ever increasing financial support to academic research in the UK. It is difficult to provide exact figures for this support, including as it does individual funding in support of LINK schemes, co-operative awards, post-graduate support, general support for research projects, specific contract research, consultancies, general donations, and the support of HEI infrastructure through capital grants. With the inclusion of the costs of clinical evaluation of potential new medicines in university and hospital clinical departments the level of support is likely to be over £100 million.

The level of research carried out in-house and through contract and collaborative arrangements with academia emphasises a point, which is often overlooked, that the pharmaceutical industry is an essential part of the UK Science Base and there is considerable interdependence between the industrial and academic aspects of it. The nature of this dependence is broad and includes:

- The recruitment by the pharmaceutical industry of trained scientists and technologists. These scientists operate in multi-disciplinary teams for which is broad range of science is needed, e.g., chemistry, pharmacology, biochemistry, physiology, molecular biology, information technology, medicine, etc.
- The elucidation, through basis research in academia, of disease mechanisms enabling targets for therapeutic intervention to be identified, allowing the development of novel medicines.
- The development and understanding of new chemical reactions leading to the development of novel compounds and eventually novel medicines.
- The development of new biotechnologies techniques enabling novel drug discovery approaches and research tools to be developed. The latter can lead to new screening methods for the identification of new medicines.
- The carrying out of clinical research at centres of clinical experties.
- The application of information technology to, for example, the understanding of the Human Genome, and analysis of data from clinical trials, etc.

4. CONCERNS OF THE PHARMACEUTICAL INDUSTRY OVER THE UK SCIENCE BASE

We are pleased to note that amongst the main aims of the Office of Science and Technology are:

- The provision of advice to the Government on all aspects of science and technology.
- The encouragement of technology transfer between the public and industrial sectors of the UK science base for ultimate commercial exploitation.
- The fostering of the training necessary to produce the skilled scientists and technologists needed for the UK science base.

We believe that the Office of Science and Technology should therefore be at the centre of many of the key issues affecting the science base. The pharmaceutical industry's concerns which it is hoped will be addressed in the forthcoming White Paper include:

- The poor perception of science by British society. The DTI through BJAB (Biotechnology Joint Advisory Board) is initiating attempts to address this for biotechnology, but other fields are not covered at present.
- The poor quality of science teaching in schools. The poor facilities for science in schools, the lack of good financial rewards, and status, for science teachers are resulting in fewer high quality graduates being attracted into the teaching profession.
- The low pay, poor prospects and lack of security of scientists in academia is having a deleterious effect on their innovative output and willingness to remain in science.
- The continuing fall in the funding of the Science Base by the Government. There is a serious decline in Government support for the infrastructure of HEIs. Investment in capital facilities and equipment is totally inadequate. Many HEIs need major investment now to correct deficiencies and to provide the necessary structure to enable them to be competitive.

- Unnecessary bureaucratic and administrative difficulties in the management of co-operative research programmes such as the LINK scheme. In addition, inconsistencies in the approach taken by the Research Councils have led in the past to fundamental collaborative research projects in the biomedical field not being funded. A central strategic policy approach for all research in this field could help prevent this.
- Possibly because of the nature of its approach to fully funding most of its research activities, the UK pharmaceutical industry with a few exceptions, has not followed closely European Community funding programmes for R&D. It is a matter of concern however that Government decisions on the support of such international research programmes, particularly in areas of "big science", have such significant knock-on effect on the Research Councils' finances.
- The "short-term" approach to grant support for projects is, we believe, limiting the scope and quality of the science that is being carried out. We believe than an understanding of the cellular and molecular mechanisms underlying many of the serious diseases affecting our society requires focused, purposeful and long-term research. The need for long-term research of strategic importance is being hindered by the present need for scientists to publish their preliminary findings so that performance can be assessed.

5. The Select Committee have raised a number of specific questions on the organisation of the OST that it would like to be addressed:
(i) *How can the process of turning research results into wealth creating technologies be improved? What might be the respective roles of OST and DTI on this?*

The availability of well qualified graduates, for both industry and academia, together with an adequately funded science base are essential requirements for the generation of new understanding from which innovation can arise.

The pharmaceutical industry's success is based on its ability to identify innovative ideas and to exploit them. This success in dependent on close collaboration between the industry and academia. Other sectors of industry will have different needs and approaches, and the Government needs to appreciate that what applies to one industry may not be applicable to other.

Successful generation and exploitation of innovation does, however, require adequate expenditure. The Association, in its submission to the Royal Society's inquiry into the Science Base, reported that it was concerned that "the Government does not appear to appreciate the relationship between expenditure on Research and Development and the national economic performance. the successful performance of the pharmaceutical industry has long been based on this relationship".

It is essential that there is adequate support given to basic research in those areas in which UK industry is able to provide signifcant added value. If not, the ideas generated in academia will be exploited elsewhere. The funding bodies should consult with industry more on the research areas that need to be supported, and there needs to be clear and focussed policies for research in areas of strategic importance. Most importantly there is a need for the development of an effective interface between academia and industry enabling the encouragement of transfer (both ways) of technology, know-how and expertise.

For results and inventions to be successfully exploited there is need for effective patent protection. In view of the pharmaceutical industry's need to invest in long-term research, development and safety testing it will have specific requirements regarding the ownership of IPR, which may not be necessary for other industry sectors.

We suggest that the Office of Science and Technology should have responsibility for the establishment of a national research policy to direct funding into the longer-term strategic projects of fundamental importance to the UK. To achieve this the OST will need to have effective liaison with the DFE, DTI and all other Government departments which will continue to fund research. The OST will also need to consult widely with the public and private sectors in the establishment of this overall policy. Through the Minister, the OST and supporting staff should advise the government on science policy and the funding required to implement it.

The DTI should continue to assist the different sectors of industry in the exploitation of research. Its role is to work with industry to identify needs and to seek the influence of the process of innovation in industry. Under the new arrangements that could be established by the OST, the DTI would function as a commissioning agency, putting forward recommendations as to appropriate fields of research that need to be supported.

(ii) *What structure does the government need to advise it on science policy?*

ACOST has produced a number of useful discussion documents on the Science Base and on specific areas of science and technology in the UK. A report on a study on biomedicine is still awaited. We have limited evidence that the Government has implemented any of the recommendations of such reports.

There has been no pharmaceutical industry involvement in the deliberations of ABRC in advising on Research Council activities and expenditure needs. It must be noted with concern that it is understood that the Government has chosen on occasions to ignore the advice of ABRC. Through the activities of BJAB (British Joint Advisory Board) the pharmaceutical industry is beginning to play an increased role in Research and Council strategy decision-making.

The changes introduced following the establishment of the Office of Science and Technology do appear to call for a review of the existing advisory structure. We consider that a senior advisory committee is required which will enable the Minister for Science and Technology to fulfil his responsibilities in providing an overall strategic policy for UK Science Policy. Such a committee would require input from the Research Councils, the main industry sectors, the DTI, DFE, the Higher Education Funding Council, and appropriate Science policy "experts". It should be the responsibility of the OST, and in particular the Chief Scientific Adviser to ensure that relevant bodies are consulted, and used, in the formulation of policy and strategy as are most relevant to the issues. The OST should be able to establish advisory machinery in a bespoke manner to consider particular issues as required. With the establishment of such an advisory machinery the need for all-embracing permanent bodies, such as ACOST, would need to be reviewed. Whatever approach is taken, there is a need for greater transparency, and increased industrial representation.

The ABPI recommends that the bio-medical and health related activities of all of the Research Councils be reviewed through a single UK national body.

(iii) *Is it appropriate for the effective Chairman of ACOST to continue to be a businessman with a technological background, or should the Minister take the lead?*

We have already expressed doubts over the need for ACOST to continue in its present format. We believe that it is for the Chief Scientific Adviser to establish appropriate advisory bodies and to ensure that the membership reflects the issues under consideration. If ACOST were to continue, albeit in some amended form, then we suggest that it should be an independent body consisting of senior scientists from academia and appropriate industry sectors. The Chairman need not be from industry, and certainly does not need to be a businessman. The Chancellor of the Duchy of Lancaster should clearly have access to the deliberations of such a committee, but it would be inappropriate for him, or the Prime Minister to chair it.

(iv) *What should be the role of the Chief Scientific Adviser?*

Following the establishment of the Office of Science and Technology, and the anticipated centralised strategic approach to the setting of priorities for research funding, the role of the Chief Scientific Adviser is of long-term, and fundamental importance. The Chief Scientific Adviser should be responsible for the setting of the budgets for the funding of the science base, the running of the Research Councils, liaising through his Minister with other Government departments and should have the authority to establish advisory committees when necessary. It is his responsibility to ensure that accurate and relevant information is available to his Minister, and to other departments on all factors affecting the UK Science Base. He should be the interpretive interface between the Government, the various industry sectors and the scientific community. The collation of data from the UK and other countries, and an understanding of the relevance will be of prime importance.

(v) *Can any problems which arose from the previous ways in which science policy was co-ordinated be identified?*

We suggest that until the recent appointment of the Minister responsible for science and technology it has not been possible for the UK to have had an effective, co-ordinated science policy. As reported in the Royal Society's report on "The Future of the Science Base" the arrangements in the UK have been weak in four key areas:

- Inadequate oversight of publicly funded research as a whole.
- Lack of effective representation at Cabinet level.
- Inadequate representation of UK interests in international fora.
- Unsatisfactory arrangements for handling major international subscriptions.

The appointment of a Minister responsible for the development and co-ordination of an overall Government policy for all aspects of science and technology, including technology transfer and training will provide the long-awaited strategic framework needed for the support of the Science Base. It is anticipated that the assumption of this responsibility for strategic direction by the Minister, assisted by the Chief Scientific Adviser, will be accompanied by the necessary budgetary control. Not only will these anticipated changes lead to an assessment of the objectives and expenditure of the individual Research Councils and how they are funded, but will also require a major attitudinal shift in the current approach to co-ordination of other departments such as the DTI.

The immediate problems that the Office of Science and Technology need to address are the previous lack of adequate Government support for the infrastructure of HEIs and the streamlining of the advisory process for Research Council spend.

(vi) *Are there any areas which experience particular problems such as, for example, UK participation in international collaborative programmes?*

The pharmaceutical industry has not played a major role in participating in international collaborative programmes such as the Framework programme. It is felt that this is indicative of the industry's specific needs relating to strong intellectual property ownership. Aspects of the near-market approach to such programmes have also been a disincentive. The industry considers that early stage basic research should be supported by the EC programmes. It is too early to say whether the industry would show interest in participating in programmes under the "generic technologies" approach being promoted by the Minister.

As we have indicated, many of the pharmaceutical industry's collaborative programmes with academia tend to be funded to ensure IPR protection. It is believed however that certain activities of the industry could form the focus of future major projects within the Framework programme. Improvements to manufacturing processes, more reliable safety tests, epidemiological studies are just a few examples. It is acknowledged that there has been a higher level of interest in the field of biotechnology, and it is likely that this area may form a topic for future involvement.

Through involvement with such bodies as IRDAC (Industrial Research and Development Advisory Committee) the pharmaceutical industry has played some part in the advising on policy matters with the EC. We believe that this consultative process needs to be expanded and made more transparent enabling greater input from the industry.

The major criticism made by those companies who have attempted to participate in international collaborative programmes concerns the excessive bureaucracy of the procedure. It is difficult to see how the companies likely to benefit from involvement, i.e., small to medium sized enterprises, can have the resources or endurance to participate.

Although we appreciate that the DTI has attempted to be proactive and get UK industry more interested and involved in the European collaborative programmes, we consider that such activities have been unfocussed and have failed to address the specific needs of the different industry sectors. Also it is felt that the Medical Research Council, with its responsibilities in connection with the EC Biomedicine and Health Research Programme, should liaise more closely with the pharmaceutical industry.

(vii) *What should be the objectives of the Minister as a member of the Council of Science Ministers in Brussels?*

We believe that the UK has not taken, until now, a sufficiently active nor effective part in the determination of science policy for the European Community. The appointment of a Minister responsible for UK science policy, and his already apparent encouragement of UK participation through the European Council of Science Ministers, is a positive development.

The main objective of the Minister is to represent the interests of the country's scientific community and to influence policy decision to the advantage of UK academia, science base and industry. The Minister will not need to be told that policy and funding decisions in connection with European Community and International Research Programmes are being made in an increasingly competitive environment. The Minister needs to be clear when involvement in collaborative programmes is within the national interests, and when it more appropriate to ensure that duplication of effort should be prevented and national programmes supported. To participate effectively in discussions at the European level the Minister needs to have a full understanding of the strengths and weaknesses of UK science.

The pharmaceutical industry has expressed doubts on a number of occasions on the appropriateness of UK involvement in certain expensive collaborative programmes which do not appear to offer any specific benefit to the country. The Minister, in committing funds to EC programmes, from a limited, and decreasing UK science budget, needs to be clear on his reasons for doing so, and should use every opportunity to reassure the scientific community on the long-term benefits of his doing so.

APPENDIX A

Royal Society Inquiry into UK Science Policy

Comments from the Association of the British Pharmaceutical Industry (May 1991)

1. The Pharmaceutical Industry in the UK

The Association of the British Pharmaceutical Industry (ABPI) is the trade association representing the great majority of pharmaceutical companies in the United Kingdom discovering, developing and manufacturing prescription medicines. ABPI member companies supply more than 90 per cent of the medicines used in the National Health Service annually. The pharmaceutical industry has consistently been one of the most successful sectors of industry in the UK over the last 40 years. In 1991 it contributed over

£1.2 billion to the UK's balance of trade and its combined exports exceeded £2.5 billion. This outstanding record is based on the industry's significant investment in research and development and on its close relationship with the country's centres of academic excellence. The continuing success of the pharmaceutical industry stems from the recognition that research, both basic and applied, is crucial to its continuity and growth. This recognition has resulted in an investment in R&D which has increased consistently over the years and in 1991 amounted to over £1.2 billion, representing approximately 18 per cent of sales. This figure is much higher than most comparable sectors of manufacturing industry.

The willingness of multinational pharmaceutical companies to go on increasing their investment in research in the United Kingdom has, in the past, been largely dependent on the high quality of the research carried out in its universities and medical schools and on the availability of well-trained, innovative scientists emerging from British universities and polytechnics. The future success of collaborative projects such as the LINK scheme are therefore of much interest to the UK pharmaceutical industry.

2. The Royal Society Inquiry

The Association is pleased to be able to contribute to the inquiry of the Royal Society if only to add its concerns to those that have already been expressed by the Society and by other informed bodies such as the House of Lords Select Committee on Science and Technology. The Association is greatly concerned that the Government is choosing largely to dismiss the seriousness of the present crisis.

Many of the issues raised in the eight policy areas chosen for consideration by the Royal Society are somewhat outside the direct remit of the pharmaceutical industry, although all aspects of the research base will have some bearing on its activities. However as an industry which is a major supporter of academic work and which employs many thousands of science-based graduates and postgraduates we feel that our brief comments will have some relevance. The Association would be happy to provide additional information if requested.

It is noted that the Royal Society intends to make public its findings on specific issues as the inquiry progresses. In view of the increasing financial problems facing academia the Association strongly advises the Royal Society to make early of its findings in order to draw attention to some of the more important current problems.

3. Government funding of civil science

Despite its claims to the contrary, there can be no doubt that the Government's expenditure on civil science has declined in real terms over recent years. Other bodies contributing to this inquiry will be in a better position to provide detailed statistical comparisons on the percentage of GDP spent on civil research annually. It is noted with concern that this country now has a very low ranking amongst its peer group of nations, not only in the percentage of GDP invested in civil science, but in the numbers of children staying on in school after 16-years of age.

The science budget of £928 million for 1991-92, announced in January, represented an increase of less than 3.0 per cent over that for 1990-91. This increase is well below the estimated rate of inflation for 1991-92. In addition the recent increase in VAT announced by the Chancellor in the Budget will fall heavily on science, a fact that even the Secretary of State for Education and Science has accepted. This serious under-funding must further exacerbate the problems of the Research Councils.

4. The Research Councils

The current situation is particularly serious for the science and Engineering Research Council (SERC) which, from its fixed budget, must support several large research facilities, including CERN. The costs of such internationally-supported projects, together with the effect of major currency fluctuations, have to be accepted as being outside the Council's control. However, the Association considers that a disproportionate amount of SERC's resources is being devoted to high prestige, high-cost areas of "big-science". This is at the expense of low-cost areas such as biology and chemistry which could better serve the national interest in terms of academic training, industrial relevance and economic rewards.

The Association believes that SERC is currently under-funded and fully supports the recommendations of the House of Lords Select Committee on Science and Technology in calling for an immediate release of an extra £12 million of funding to help overcome SERC's immediate problems. The proposed addition of £15.8 million to the 1992-93 indicative science budget allocations for SERC announced on the 22 May by the Secretary of State will be too late to resolve the crisis.

The resources of the SERC and the Medical Research Council (MRC), which could be devoted to responsive-mode funding such as grants and studentships, are being placed under increasingly servere pressure. The announcement that the amount of money available from the SERC to provide grants to young researchers has fallen from £45 million last year to £24 million this year, and that it is unlikely that any new projects will be funded in 1991 was noted with extreme concern. This is particularly serious as SERC and other Research Councils play a major part in sponsoring the training of research scientists.

The pharmaceutical industry carries out a significant proportion of the sponsorship of postgraduate training schemes such as the SERC CASE awards, the comparable MRC collaborative awards, and in collaborative research programmes under the LINK scheme. However, there has to be a recognition by the Government that industry's role can only be supportive and that responsibility for the long-term funding of the Science Base at a level equal to that in competitor nations, such as Japan and West Germany rests squarely with the Government.

5. Industry/academic collaboration

The pharmaceutical industry in the United Kingdom has a history of successful collaboration with Research Council Institutes and Higher Education Institutions (HEIs). Companies currently spend a considerable amount of money on extramural research and a substantial proportion of this expenditure in the form of capital and revenue payments. In recent years encouragement of such collaboration has become part of Government policy, and HEIs have been expected to generate some of their income from industry either in the form of direct contract research payments, or via collaborative research projects. Industrial and charitable funding of university scientific research has doubled in recent years. The pharmaceutical industry welcomes this policy but strongly believes that in addition to this project-funding approach there is an obvious need for the Government to maintain its support for the long-term fundamental, curiosity-led research which may well form the basis of tomorrow's scientific breakthroughs.

The Association has noted the development of certain trends, which it feels will, in the longer term, militate against effective collaboration. Companies are fully prepared to pay all necessary costs and overheads associated with contract research carried out at their request. They should not however be expected to support the infrastructure of HEIs through the payment of disproportionate overhead charges in collaborative research projects. The maintenance of the infrastructure of HEIs must be the responsibility of the Gvoernment. There appears to be a fundamental misunderstanding in academia between contract research and collaborative research which, if not resolved, could lead to further problems in this area. The pharmaceutical industry, which invests considerable sums on its own in-house R&D, has limited resources to support extramural collaborative research which may not have direct commercial applications. Companies have to put their investment where it is likely to lead to the best results for them. The pharmaceutical industry operates in a competitive international environment and will feel obliged to support research elsewhere if the quality of research in the UK deteriorates or the costs go up. The support of postdoctoral collaboration in the US and Europe is now becoming better value than in the UK.

Cuts in research funding have, it is believed, contributed to the continuing flow of senior scientists away from the UK. As the Royal Society will know only too well, in the years 1960-62 only 4 per cent of the eminent scientists elected as Fellows had emigrated to the USA. We understand that in the years 1988-90, 15 per cent of new Fellows had already emigrated to the US by the time they were elected.

6. The future supply of research scientists

Every year the pharmaceutical industry needs to recruit approximately 2,000 graduates, many of whom need to have a thorough knowledge of science. It is noted that the present inquiry does not intend to address the public image of science nor the declining interest in science studies among pupils and teachers. However, in seeking to identify priority policy issues that need to be addressed to ensure the long-term goal of a healthy research base in the UK by the year 2000, the Association believes that the Royal Society needs to address the reasons for the current shortage of students studying science at higher education, before an irreversible spiral of decline takes place.

Science-based industries such as pharmaceuticals and chemicals recognise that they have a role to play in generating interest and awareness about science among school pupils, beginning at primary school level. The Association and its member companies have launched a programme of action targeted at this audience, by providing educational material and creating industry/school links.

More high calibre science teachers, attracted by a fair financial reward, good conditions in which to work and secure career prospects, would improve the standard of science teaching. Only improved teaching, better resources and greater syllabus priority will produce the school leavers able and eager to embark on a degree course in a scientific discipline. The publication of the Royal Society's Report on post-16 Education (Beyond GCSE) and the recent launch of the White Papers on Further and Higher Education will obviously lead to some changes in this area.

During their undergraduate years students must be convinced that staying in science and using their degree experience can lead to an interesting and rewarding career. More graduates should also be encouraged to undertake further study for doctorates or other higher degrees. The current concerns over the science budget and the lack of sufficient funds in the Research Councils to support much research in the near future are not likely to provide an atmosphere which encourages graduates to enter research as a career, particularly in the academic sector. It is also difficult to see the current drift away from post-graduate research being reversed until signficant improvements are made to the stipend offered to PhDs. Failure to produce the scientists and technicians of tomorrow will inevitably lead to a further erosion of the Science Base.

7. SUMMARY

The ABPI welcomes the establishment of the inquiry by the Royal Society and hopes it will contribute to a change to Government policies on funding and a return to a healthy research base in the UK.

The scientists of today are needed for the economy of tomorrow. The Association is deeply concerned that there is a persistent erosion taking place of the quality of academic science in the UK. Without more support, financial and otherwise, from the Government it is certain that this country will not be able to maintain the pre-eminent position in science that it once held.

The Parliamentary Under-Secretary of State for Education and Science (Mr Alan Howarth) recently stated that "(the Government) shall continue to support British science but the extent of that support depends on the progress of the economy". The Association is deeply concerned that the Government does not appear to appreciate the relationship between expenditure on Research and Development and the national economic performance. The successful performance of the pharmaceutical industry has long been based on this relationship. Unless the Government accepts that this relationship applies to all aspects of the Science Base it will not realise its economic objectives for the nation.

Examination of witnesses

Dr Brian Richards, Chairman of British Bio-technology Group Plc, Mr Ian Cooper, Chief Executive, BHR Group and Dr John Taylor, Director, Hewlett-Packard Laboratories, Europe, Confederation of British Industry; Mr Paul Lester, Chief Executive, Graseby Plc, and Professor David Balford, Chief Scientist, Westland Helicopters Ltd, Engineering Employers' Federation; Dr John Brophy, General Manager Corporate Research, BP Chemicals Ltd, Dr Michael Caton, Director Scientific Relations, Rhône-Poulenc Ltd, and Mr Dough Rodger, Executive Director, Business Development, Chemical Industries Association; Dr Michael Elves, Director of External Scientific Affairs, Glaxo Group Research Ltd, and Professor Trevor Jones, Director of R&D, Wellcome Plc, Association of the British Pharmaceutical Industry, examined.

Chairman

267. Gentlemen, welcome to the Committee and thank you for agreeing to come as a group, albeit we understand and recognise the separate interests which your individual organisations have. You will be aware that this Committee's inquiry into the OST structure and policy precedes the Chancellor of the Duchy's White Paper and is being conducted on a timescale which, frankly, does not permit of many individual evidence sessions. I hope you will understand our predicament just as we understand yours. What I propose to do is invite each of the organisations to make a short opening statement, if they wish. We will then proceed to the questions which in each case we have allocated to a certain organisation—though no doubt others will wish to comment on the exchanges - in order to cover the range of talent before us. Perhaps I may first invite the CBI to make an opening statement, if that is their wish.

(Dr Richards) Mr Chairman, we are very pleased to be here and thank you for inviting us. First, I introduce my two colleagues: Mr Ian Cooper from BHR Group is on my left and Dr John Taylor from Hewlett Packard is on my right. We are members of the CBI's Technology and Innovation Committee (formerly the Research and Manufacturing Committee). Though we are today representing the CBI we are delighted to be here with our colleagues from other trade associations. As Members will know, the CBI represents about a quarter of a million companies. To make one adventitious comment, the membership of the CBI continues to be strong even in these times of recession. Those companies are drawn from a variety of sectors of industry. We represent some of those sectors. I think Members should be prepared for the fact that there will be some shades of view between people from different sectors. What I will try to do is take a somewhat overarching view of the subject under discussion, namely, the role and organisation of the OST. The CBI sees the primary role of the OST as the vehicle and forum for the interface between the science base and industry with the formal participation of the DTI. The purpose of that primary role is to ensure that the science in this country provides the opportunity for industrial innovation and competitiveness. In our view, the key word is "innovation". Recently, the CBI Council prepared a statement—which although not yet published formerly has been sent to Members—that made five key points. In order to be more competitive we need more effective innovation management strategy and practice within companies we need national co-ordination of, and strategic direction for, technology and innovation and a proper way of exploiting science and technology. It is only industry that can bring innovation through to the end result of increasing the wealth of the country. We need better communication about innovation between industry and its investors. Finally, I am sure everybody agrees that we need a better approach to education and training to provide the skills for technological advancement. To interject a personal view, I see innovation as a continuum from the inventive step through the feasibility step—where the ideas are put to the test in terms of their practicality—to the development step in which marketable products are conceived and produced. The final step is the marketing and sale of those products and thus the creation of wealth. I should like to leave two points clearly in the mind of Members. First, there is a need to address the "continuum" issue, not just industry and the science base considered separately. The science base, which will be one of the major preoccupations of the OST, is presently conceived primarily as a supply organisation creating new ideas and supplying them in a manner that may be useful to industry. Secondly, therefore we would like to see the balance between supply and demand—or push/pull—addressed in the context of the OST. We would like to see the OST provide what I call a triumvirate forum in which they, the DTI and industry have equal representation. It is in that forum that one would wish to address issues of national importance. I end by saying that the CBI stands ready to identify and field people for addressing such issues. The key point is that we would wish to see in that triumvirate practitioners and people with track records of achievement.

268. I should perhaps have said that the Committee has received a number of written submissions of evidence. Much of the individual proposals sent to the OST in the consultation period will be part of the evidence we have already received, as it were. In inviting you to make comments I would like you to be brief but to make them on the assumption that the evidence sent to the OST has largely been sent through to us. Mr Lester, do you wish to say something on behalf of the Engineering Employers' Federation?

(Mr Lester) To give some background, the EEF represents 5,000 companies all of whom are in the manufacturing and engineering sector. Unlike the CBI which covers a wider range of industry we are focused very much on the engineering sector. I think

[**Chairman** *Contd*]

the critical factor facing us now is the lack of a strategy plan for the country. To make it absolutely clear, the plan needs to recognise investment in our technology; it has to have a strong marketing input to what technologies can be developed into real products. That is a key point. Everything flows from that, in the sense of what our universities and companies specialise in and what companies invest in. What it means is that there has to be a selection process, separating out "winners" and "losers". For example, half of industry could be amongst the winners—biotechnology, pharmaceuticals, some aerospace activities, medical equipment manufacturers and others. In those market areas they can win significant slices of the world cake as against the competition. Other companies, which may be limited to supporting United Kingdom activities, would not receive the type of support, funding and activity that we have in mind. That master plan has to be worked out between industry and the Government (DTI) and has to include a technology focus. Until that plan is worked out we could be wasting a lot of money at this very minute on research going on in industry and our universities. Against that background we can get the training and school structures right and everyone will understand what they are going to do. I believe it is critical that that backcloth should be understood by everybody in the room.

269. Does the Chemical Industries Association wish to make an opening statement?

(Mr Rodger) I am a member of staff of the association. I shall begin by introducing my two colleagues. On my left is Dr Brophy, general manager corporate research at BP Chemicals, and on his left is Dr Caton, director scientific relations at Rhône-Poulenc. The association has a membership of some 200 companies. These span the full range of activities in the chemical industry from, at one end, high volume products through to high-value added products such as pharmaceuticals. Many pharmaceutical companies are members of the association and many member companies are also in membership of the CBI. The chemical industry is a very successful one; it is the United Kingdom manufacturing industry's number one export-earner. That success has been based on science and innovation. The United Kingdom publicly funded science base provides the essential underpinning of our success. It would be difficult to overstate the importance of that science base to us in terms of both the fundamental research carried out and, perhaps even more importantly, the provision of well qualified people to go into industry and academia. The United Kingdom has a strong and well-regarded science base, but it would be wrong to be complacent about its strength or to take its future health for granted. We believe that adequate public funding of that science base is necessary and that it should be partly targeted to strategically important areas but not exclude curiosity-driven research. We believe that to be necessary to maintain the quality of the science base and thereby to lay the foundation for the continued success of technology-driven industries like the chemical industry. We are very encouraged by the creation of the Office of Science and Technology within the Cabinet Office since it provides an essential vehicle for the strategic assessment of science and technology policy and research priorities. We believe that the effectiveness of the Government's substantial expenditure on research and technological development can be assured only by adopting a clear and consistent strategy for science and technology and acting in accordance with that strategy in a consistent manner for an extended period of time. One essential element of that strategy is a co-ordinated approach across all government departments and, above all, a common understanding of the priorities and roles across the OST, Department of Education and the DTI. We attach a great deal of importance to the White Paper consultation process and the inquiry being carried out by the Committee. We shall try to be as helpful as we can in responding to your questions.

270. Does the Association of British Pharmaceutical Industries wish to make an opening statement?

(Professor Jones) You will know my colleague Dr Elves. I am also supported by Dr Kipling sitting behind. We represent a very successful part of British industry and science. That industry is dependent in large measure, if not almost entirely, on the health of science in this country. I make three brief points in opening. The first relates to the nature of our science base; the second relates to policy and science; and the third is concerned with the organisation of those activities. To us the science base is a mixture of universities, research institutes and industry itself. Very often the third sector is forgotten when we discuss the totality of activity and funding in this country. In our industry we have a need to ensure a good supply of highly innovative and good graduates and technicians and a healthy, stable and purposeful research activity where the uncertainty factors are minimised and academia is given a base on which it can build confidence for the future. You all know the litany of our success. The balance of trade in relation to our sector is over £1 billion a year. We spend more than £1.2 billion on research every year. We employ 88,000 people, 250,000 indirectly and have 18,000 scientists in our industries. That is a success story in Britain if ever there was one. Given that that science base is an essential part of that success, if we are to maintain it, it seems to us that policy is a central component of it. We welcome the formation of the OST in that regard. We strongly feel that it ought to be seen as the focal point for developing broad and detailed policies against which our success will continue, not just in the medium term but—particularly in the case of our industry—the long term. Diseases do not yield their answers readily by way of short-term research. We need a commitment to long-term funding to continue our international success and to

[Chairman *Contd*]

build the inevitable link with Europe and the eventual links with other countries. The third point concerns management. We believe that the new structures which have been put into place offer a chance to co-ordinate, fund and manage the global activities of science in this country. We feel that that can best be done through the medium of a properly constituted committee structure. Undoubtedly, ACOST and ABRC have served a useful purpose but we feel the time has come to rethink that structure. The group within OST could then clearly manage, co-ordinate and fund the activities of research using selected committees in individual sectors.

271. To open the questioning, it will not surprise you to know that many witnesses have complained about what they call the short-term view of industrial investment in research and development taken by both financial institutions and industrialists themselves in some cases. When he gave evidence to us the President of the Board of Trade told us that short-termism was a natural reaction to economic uncertainty and that the situation would improve when the conditions for low inflation and sustainable growth had been met. Do you agree that British emphasis on short-term profits is simply a reflection of its economic experience, or are there other and deeper reasons for that attitude which may not be driven purely by economic considerations?

(Dr Richards) We have all heard a good deal about short-termism. I think that the President of the Board of Trade's views are not ones that we would share. Short-termism is somehow part of our culture; it is around in good and bad times. It may seem worse in bad times, but there is no doubt that investors generally feel that quick results are needed and there should be a real time impact on the Profit and Loss Account. Our view, which I believe would be shared by all technology-based industries, is that you need substantial investment together with short-term and long-term objectives. It is continuity that will provide us with the answers to intractable problems and create real opportunities.

(Dr Elves) I speak from the pharmaceutical point of view. We are an industry which of necessity cannot take a short-term view. Some drugs once discovered may require a 12 to 15-year development period. We are pretty used to working according to a long timescale of operations. The aspect of short-termism that is concerning us increasingly is the short-term view of the funding of research in the public sector on which we depend. To amplify that, a lot of our success up to now has been in the area of common diseases whose mechanisms and understanding have not been that important. We have been able to apply classical pharmacological and biochemical technologies to tackle infectious diseases, abnormal blood pressure and things of that kind. We are now faced with a very different medical and social situation in which we have to cope with problems like Alzheimer's disease, rheumatoid arthritis, osteoporosis, psoriasis and the like which are a significant source of misery and socio-economic loss. We do not understand the molecular and cellular basis of those diseases and therefore cannot find new drugs to treat them; we have no targets at which to aim those drugs. We will find those targets only by properly understanding the diseases and that is best done in the public sector science base, particularly in medical schools and research institutes associated with them. The current traditional three-year funding round has nothing to do with the economic cycle. It was there when I was an academic some years ago and is still with us. Consequently, the young and productive research worker is spending at least one third of the time worrying about where his next penny is coming from both for his research and his personal support. We would very much like to see a more fundamental policy review being carried out in that area together with appropriate funding on a time basis that will give us the best chance of understanding the issues. It is a multidisciplinary function, not just a medical problem. This area covers everything from medical instruments through to the molecular biology of the brain.

(Mr Lester) If I may use my own company as an example to try to answer the question, we are a high-tech electronics business competing in a world market. Fifty per cent of our products go to the export market. Last year we increased our R&D expenditure by 50 per cent. That was quite a dramatic step in view of the recession. Our profits were level; we did not increase them. A survey of our shareholders revealed that 85 per cent wanted a dividend and the remaining 15 per cent preferred us not to pay a dividend but to reinvest it back into the company. It so happened that 10 per cent of that 15 per cent were American investors. That picture is very similar when I speak to industrialists in my sector, and it is probably true in a lot of others. If I were to double the R&D spend again—and we certainly have an opportunity to do it in a fast-moving market—we would probably be acquired by an offshore company who would say, "They have spent all that money and they are ready to turn it into products. We can get it very cheaply because they are not making any money". Our investors would probably be quite happy because they would get quite an increase on the present value of the business relative to the share price. We have to play an extremely difficult balancing game between investing and keeping our shareholders happy.

Mr Powell

272. Some industries have excellent records in supporting R&D expenditure; others much less good or no record at all. There are many who think there is a close relationship between such investment and subsequent commercial success, notwithstanding the short-term pressure just identified by Mr Lester that militates against such expenditure. What role do you think the Government have in encouraging that research and development?

[**Mr Powell** *Contd*]

(Mr Lester) Assuming we have a strategy or plan that there are certain markets we wish to expand in terms of the United Kingdom export market—in other words, to be the world's best—certain industries will need some form of protection particularly from the threat of offshore acquisition. One could then focus the technology effort that goes into the strategy. If one takes a piece of money that is being spent out there today and it is focused on that sector one will get a huge increase in the potential for taking the technology and turning it into winning products.

273. Do you confine your answer to protective measures to prevent takeovers?

(Mr Lester) I think that has to come into the thinking, as it does in Germany and Japan. It is impossible to buy a Japanese or German company. It sounds easy to go out and buy a German company but you will find that the German bank protects the particular company.

274. To be clear, you are saying—and I would like to know whether everybody else agrees with it —that the single most important thing the Government can do to assist the research and development base is establish mechanisms which will prevent takeovers of companies engaging in such research?

(Mr Lester) That was not what I said.

275. It is a threat?

(Mr Lester) Yes. The Government need to support that R&D effort in a fiscal way so it can be increased in those areas.

Sir Trevor Skeet

276. Dr Richards, you represent 250,000 companies which is a pretty large slice of British industry. You have good scientists and poor results. It would seem to us that there is a big difference between what Dr Elves and Professor Jones said about the pharmaceutical industry and some of the poor figures that appear in industry generally. Is it a matter of preoccupation with dividend that may come up at the end of the year? If it is that how can you expect the Government to change the system? In Europe it is dependent on the banking system; in the United Kingdom it is dependent on the equity market. Since you are very keen to keep up your share price how can you see an improvement in order to make better use of your scientists?

(Dr Richards) When I said we need a cultural change I meant that we need it also in industry. The CBI is making sterling efforts to put across arguments to show to members that preoccupation with dividends is short-termism *par excellence* and all industries should be looking at opportunities to invest in research and development. If government can provide some help for what might be called the weaker, smaller industries to make such investments without increasing their vulnerability in the way Mr Lester suggested I think we would see a change in culture throughout industry. At its conference yesterday the CBI produced a document explaining, amongst other features, how to bring about changes of this kind within the system. We have to change just as much as anyone else and would like help with that change.

277. Since 1945 we have benefited from the considerable amount of scientific work done during the war. It is not apparent to me that there has been a useful transfer of scientific information from the defence industry, nor does there seem to be any vast improvement in the companies in the Community. If there has been continuity of a rather poor experience since the war can one say whether it is governmental or company responsibility?

(Dr Richards) The balance of responsibility has probably been changing. There is no doubt that in respect of some technologies developed in the wartime context—which were prodigious—commercial exploitation was sometimes difficult if not impossible. Investment by companies in technology-driven activities which were prescribed by, say, MoD requirements clearly had to be shoe-horned into other applications. I am sure other colleagues can give examples of that.

(Dr Taylor) I should like to amplify two points. First, when talking about innovation one is talking of a process that begins by understanding a customer need and finding a way of bringing a solution to the market place profitably. That is one of the things that has to change as far as the defence technology-based industries are concerned. They also need to put in place the ability to go and look at new customer needs in the market place and devise products they can bring to the market place profitably. I think that is what we really mean by "innovation".

(Professor Jones) I do not see it as an "either or" situation. We are talking about partnership in the science base. In my opening comments I mentioned the necessity for a partnership between the education sector and the research institutes funded by charities as well as government and industry. Protectionism is one thing, but frankly the greatest defence to a takeover is success. If that partnership is on a stable basis where bright ideas are allowed to flourish with confidence that will be the recipe for the future.

Mr Batiste

278. Pursuing the point about the threat of takeover and directing my question specifically to the CBI which has 250,000 members, I have put that point to managers of pension funds in the city. They say that your member companies tell them that they will be judged on the basis of three months' performance. Is the solution not in your own hands by giving to your pension fund managers in the city more strategic instructions as to how they should apply your funds?

[**Mr Batiste** *Contd*]

(Dr Richards) I represent a small company that has to convince investors that they have to be very patient because the business has very long-term objectives. By the time it produces its first product it will have spent £150 million of other people's money. What I am saying is that it is possible to convince pension fund managers that long-termism has benefits.

279. My question does not relate to that but to the slanting which your companies themselves give to their investors in terms of their planning horizons?

(Mr Cooper) The answer has to be yes.

280. Why do you do it?

(Mr Cooper) We have to. One of the things the CBI is talking about at the moment is an attempt to improve the relationship with the investor community. It is absolutely vital that we do not only what you suggest but also explain the investment strategy and carry our investors along with us. I agree that that has to be a two-way road, but that is something we will be doing.

281. That is not an answer to my question. I accept that from your point of view you have to try to explain to investors what you are doing, but from the other side of the company someone in the same building is telling those people that they will be judged on a three-month basis and if they fall at the hurdle of a takeover they may be out on their necks. That is what is being said across the city as to why they make those judgments. Why have you not dealt with it?

(Mr Cooper) I can talk of my own company. We do not take that view with our pension fund. I agree with you that as the CBI we have to take a longer-term view.

(Professor Balmford) Perhaps I may return to a point made by Sir Trevor Skeet. One of the main problems has been that defence investment has been gradually withdrawn from the area which has been related to technology development and demonstration. In that way it has caused the defence industry not to be able to bring products to commercial fruition with the same success that it did some time ago. We still have that success but it is based on investments made 10 or 15 years ago. Thinking particularly of the defence side, if one gets to the point of having a national strategy—which must include civil spin-offs and applications for the health of the industry at large—one can shift the centre of gravity of activity from the research end to the application end. The issue that relates to the war situation, if you like, would not then occur. We would be capitalising on the inventions which the science activity had created. At the moment we are missing out on the ability to develop those applications. We have to identify them, agree them and then move the centre of gravity so we bring them to fruition. That is not what we are doing.

Mrs Campbell

282. Dr Elves talked about public sector research. He seemed to be very clear that there was some research that should be done in the public sector and some should be done by industry itself. It does not seem to me to be very clear cut. Obviously, it is very easy to be able to say, "It is no good our investing in research because we need a public sector base on which to build, and anyway it would come back to government". How does one decide where the division should take place?

(Dr Elves) In our industry it can be reasonably clearly defined; for other industries it would be very difficult. In the case of our large companies there is a critical mass of science researchers. Therefore, on our side of R&D we can cover a very wide range of activities from the near-to-the product identification end to the near-to-identifying the target end. However, we are limited by the materials with which we need to work. When we start to address fundamental questions—for instance, about the human brain and knee joint—we cannot do it without having the human brain or knee joint available, preferably in a living patient. That is where our partnership with the public sector medical sciences comes in in a big way.

283. Do you see your role as encouraging the public sector perhaps by specific grants, working with the public sector or following specific projects? How much are you doing at the moment? Is that a way of expanding research rather than your own industrial research?

(Dr Elves) Inevitably, the nature of the research we support in the public sector has to be speculative. What we try to do is focus our collaborators in the university medical schools in the direction we believe they ought to be taking to get mutually acceptable progress. The industry itself spends well over £25 million a year in grants to public sector institutions for basic research. That is quite separate from the much larger amount we also spend on clinical trial support that is given to university medical schools. The answer to your question is that we do what we can to direct the science in the areas we want it, choose our collaborators for their expertise and their facilities and infrastructure and fund them. We are more and more moving away from the three-year traditional concept and taking on longer commitments of perhaps five years or longer. My own company has just committed itself to 10 years of basic science research at the University of Cambridge. That is undertaken jointly by industrial scientists and academic scientists.

(Dr Caton) I would like to support that and extend it to other areas in the chemical industry within my experience. What has been said applies much more widely. There is blue sky research in the universities not targeted to any commercial application. We also see universities undertaking work potentially of commercial importance but of a long-term nature of which we can take advantage. The chemical industry has very strong links with the

[Mrs Campbell *Contd*]

universities—indeed, a symbiosis—so that by interacting we can take advantage of longer-term research which we are not really geared up for. That applies for example to agrochemicals just as much to pharmaceuticals and fine and heavy chemicals. A lot of research is going on into environmental problems and factory processes where we need to improve efficiency to make us more competitive.

Mr Williams

284. Professor Jones, in your introductory remarks you made comments on the importance of the health of the science base to your own research effort. Several industrial witnesses have told us they are very concerned about the weakness of our industrial base. Do you think there is a threat to our industrial competitiveness?

(Professor Jones) I think that that will depend on our ability to maintain the healthy state of both research and the graduate and technician population in the universities. Every time I walk through my own university areas and in others I see evidence of the fabric of the educational establishment suffering. I see de-motivation amongst academic groups and uncertainty about their future. That is not a basis for confidence in the future. If we can put in place strategies and policies, given that the balance of money between them is within a certain bag of cash, that will give them confidence in future. True innovation and success is probably more dependent on individuals in this environment following their nose, that is, enquiry-led research in an environment which does not constantly ask for relevance. If you will, it is "Faradaic" research. I refer back to the House of Lords definition: basic, strategic and applied research. Fundamentally, I believe that you have to give people in the science base confidence to follow their nose and provide them with the quality of equipment and support that that entails. You cannot say, "Please find me a cure for this or that". That is not innovation; it will give you copy products. If you get to that point then funding it becomes important. As Dr Elves and other colleagues have said, we do that. To give another example, I do not think we really understand how breast cancer occurs. We are funding a major programme to look at the basic aberration of the proteins. If that unlocks a clue to us the strategic research can follow up with some activity which may take 10 years. The health of it is dependent on continuing to provide a culture in which those kinds of ideas occur. We will play our part in that.

(Mr Lester) Perhaps I may make clear that in the engineering sector it is a different picture from that in pharmaceuticals. First, the majority of our spend (85 per cent) is directed more to the development cycle of a particular technology. It has to be market-driven. Blue skies thinking is very limited by the nature of the business in which we are engaged. Secondly, I heard yesterday that, frighteningly, a number of universities were seeking to fill a large number of vacancies in engineering and were willing to accept 'A' level students with an "N" pass, that is, a fail. That is probably the most telling point of the morning relative to our education system. In engineering we are now willing to take on very low-calibre people for what needs to be high-calibre work.

285. What you say is disturbing. It is clear that APBI and the pharmaceutical industry spend more on research and development and their record is a great success. How much truer would your comments be if they were applied to industries that spent far less on R&D? I turn to Mr Lester's comments. The malaise is not just in higher education research departments or university courses; it goes down to the schools and the calibre of students doing physics, chemistry and biology. There has been a swing away from science. As a scientist in the 'sixties when I became a student I thought that that would be a problem identified and then tackled and 20 years later it would be solved. That problem is common in Britain unlike the position in Germany, Japan and some other industrialised countries, is it not?

(Professor Jones) Most of us became scientists because of inspired teaching and in the environment in which that teaching took place science was respectable. Science is not high on the litany of this country. When one opens a newspaper, turns on the television or hears discussions it is not often the case that science is a regular part of the debate. I admit that it is only a component of our society but it does not have a high enough profile. Scientists have not been seen in recent years to have the profile of former years. As an industry we have set about doing something about it by devising programmes with various professional bodies to go into schools and help them at that level. We are seeking reciprocal support from government and its institutions to do that. If we do not do it inevitably we can expect to see fewer come forward.

Mr Batiste

286. I was wondering about the extent to which industries fish in the international science pool rather than just the domestic science base. I listened to a seminar organised by the Toshiba Foundation in relation to the Japanese industry. Much to my surprise, they said that Japanese industry drew almost exclusively on its own domestic science base; recruitment from outside scientists was relatively limited. As one goes down the scale from basic to applied that may be true, but what is the experience as far as Britain is concerned? To what extent do we fish abroad?

(Dr Elves) We are an international industry and we fish abroad very extensively. One third of my company's research effort takes place in the United States; other bits are spread round Europe. That gives us access to the international academic environment, and we use it.

[**Mr Batiste** *Contd*]

287. If one takes basic, strategic and applied research, I imagine that for basic research the international pool is more easily accessible; information flows more readily. The nearer one comes to the market place the more companies tend to follow the science base in their own countries. Is that right?

(Dr Elves) That is not true, because the science base includes the people. For example, we draw on the expertise of scientists in the United States to fill our laboratories in the United States. We also put British scientists into our US laboratories, often to lead the science activities there. Our industry is pretty international. We switch people around; we have non-UK Europeans working in our plants in this country and British scientists working in Europe. We see no international barriers and feel free to take the advantages that the science bases confer no matter where they are.

(Dr Richards) I was going to say that the scientific community is like a local village. We have friends and contacts as well as the normal methods of communication. Information spreads very rapidly. In recent times it has been a matter of some concern that the commercial potential of some cutting edge research is so great that that village-like atmosphere is beginning to disappear. As Dr Elves has said and I am sure Professor Jones and other colleagues would confirm, it is essential that if one wishes to be competitive nationally, let alone internationally, one needs to have one's finger on the pulse of science and all its aspects throughout the world.

(Dr Caton) It is true to say that the big companies are generally international ones and draw on the international science base, but when it comes to having close collaboration with universities through one's own laboratories one needs for geographical and practical reasons to have a very strong local science base. One cannot keep popping over to America. We are very dependent on a strong science base in this country for our own laboratories. Also, when it comes to deciding where to site manufacturing and research nowadays an international company will look closely at the strength of the local science base. They will ask themselves whether they should invest in Britain or somewhere else and look at the science base. That means jobs not just for scientists but for all other people who go with them.

288. I am glad you have made that point. It seemed from the other answers to that question that the strength of the domestic science base in Britain was not parallel to the success of the R&D undertaken by industry in the sectors concerned?

(Dr Taylor) I think the important point is that as we move towards the realisation that not everyone can do everything. Most large organisations, whether universities or industrial companies, know they cannot cover the whole span of technologies. It is very important to think about inward technology transfer to British companies to make sure there are mechanisms for those companies to get at the technology they need wherever it is being done. An important function of some of the United Kingdom science base in the universities may be not necessarily to do it all themselves, but to be very well connected to other places.

289. One of the complaints one hears in the United Kingdom—obviously, it varies from industry to industry because some relationships are better than others—is that on the whole British industry is not very successful in drawing down the wealth from British universities, so why should it be more successful in drawing it down from foreign universities?

(Dr Taylor) I think that is a separate question in the sense we have been saying all along that one of the things we need to do in terms of a culture change is to increase the pull in some sectors on the technology base. We also have to face the fact that as time goes on that technology base is increasingly an international one. In a sense it is another dimension to the problem that needs to be addressed.

Sir Trevor Skeet

290. Professor Balmford, I will be corrected if I am wrong but I believe that the helicopter was developed in the United Kingdom but exploited in the United States by a private company. The question arises as to what role the OST should have. What makes you think that a government department can do it better than industry? What do you think industry should do to improve its own performance?

(Professor Balmford) Your first statement is factually correct. The helicopter was developed in Scotland. A lot of the pioneering work done in the early part of the war passed over to the States who turned it into a viable aircraft. What can the OST do? I come back to the issue of a national strategy and agreed plan into which government and industry put their total investment. That is essential for future aeronautical activity, together with the earlier point that the bit that brings it to fruition is a much more costly phase of activity than the actual invention. We are taking support away from the bit that brings it to fruition. Industry cannot afford to do it on its own. I am talking, perhaps parochially, in relation to the aerospace industry. Individual projects are enormously expensive and they require extensive collaboration. The number of products is relatively small but the cost of each is extraordinarily large. We have to find a way of funding that phase of activity which comes after invention but before it goes out of the factory gate as a saleable product.

291. Since the war we have set up one committee after another: ACOST, CEST, ABRC for the distribution of funds and so forth, but we have not found a very convenient or sound way of being able to define the essential priorities. Is it really the function of industry to do that or is it the function of government?

[**Sir Trevor Skeet** *Contd*]

(Professor Balmford) I think it is the function of all parties together. I believe this brings us back to an earlier statement made by one of my colleagues on the right, that is, the triumvirate between the OST, the DTI and industry.

292. Triumvirates are unsatisfactory—as Caesar found!

(Mr Cooper) There are four parties: government, industry, academia and the financial world. Under the OST we have a chance to try to get all of them together to set national priorities. In the past the trouble is that we have not had the overarching inter-departmental view that OST has the opportunity to take. What is important is the partnership under OST where together all the constituents can try to set priorities.

Chairman

293. You will be aware that in the description of the OST in the White Paper reference is made to it having an "overview". That is not a particularly potent word. What you are really talking about is enforced co-ordination or prioritisation. Would that be fair?

(Mr Cooper) Yes.

Cheryl Gillan

294. In the light of what you have just been saying, are we not running the danger of concentrating on what we are looking at today in terms of industrial application? Would your comments apply when we are looking very long term as far as industrial applications are concerned? Do you still see this triumvirate coming into operation, or do you think that government really has a role to play in picking the winners on a long-term basis?

(Mr Lester) The answer to both questions is yes. You have to have a strategy that is long term, that is square one; it has to be for the next 20-plus years. The Japanese did that 20 years ago. They have stuck rigidly to their strategy in terms of being the technology leaders in certain markets in which they will expand. Our strategy has to identify what markets we wish to be in and what technologies we can apply to that area. Within that strategy there is also a need for the speeding up of the development process which will bring products right now from current innovation that we have in industry—in some cases the public sector—into the market. As a country we tend to be very slow in getting our products into the market place.

(Dr Taylor) The notion we need to have is one of not picking short-term product winners but identifying potentially very fertile areas for medium and long-term activity where the United Kingdom has at least a plausible route to the market place at some time. It is the task of looking at fertile areas where we have some credible chance of taking things to the market place eventually that the overarching group needs to deal with. It needs to set some long-term measurable goals as well as strategies.

295. You think that the Government should help set priorities but should listen to the view of industry?

(Dr Taylor) Absolutely!

Mrs Campbell

296. I have heard it said—but I have no evidence to corroborate it—that if one looks at research papers published by universities and research councils 20 or 30 years ago those published in Britain tended to have a higher success rate in leading on to real products at the end of the day than those from, say, the United States or some of our European partners. Would you agree that we have been moderately successful in the past? Is there a danger that by being too selective we pick losers instead of winners? I appreciate it is a very difficult area, but I would welcome a comment on that statement.

(Dr Elves) To some extent what is said is perfectly true. The situation as regards scientific publications —where a lot of the science information is based —is that that is determined by the short-term view of life. Thus, talking mainly about the medical sciences the scientist is prepared to do quick experiments that result in quick papers rather than plunge himself into a fundamental problem that will take a long time to solve and will not produce many papers though the solving of that fundamental problem will result in a paper which is a blockbuster. We saw that in the late 'fifties with the work done in Oxford on immunology. The fundamental work that underpins all modern immunology came out in about three papers by Sir James Gowans. In the meanwhile he published very little. I do not believe that given the current funding structure that is possible.

Mr Powell

297. I want to return to one point made by Sir Trevor Skeet. He referred to Caesar and triumvirates. I have listened to what has been said about priorities and all the rest of it and I have no clear idea as to who should decide. Whom do you think should decide? Referring to the fact that the OST has laid down that its function will be one of having an overview—which is not very strong—is it your fear that the OST is not going to be anything like powerful enough to be able to set the national strategies for which you are asking?

(Dr Richards) I believe that Mr Powell has put his finger on it. We do not think that in its present form the OST can fulfil what we see as perhaps the most important issue to be settled in this whole area, that is, the setting of national priorities. As it presently stands, the OST will not have the relevant resource. Therefore, it must act in collaboration with the DTI and industry, which also includes the financial industry. It is only at that level that one can set national priorities.

(Mr Lester) In the country we have only a certain amount of money available both in industry and

[Mr Powell *Contd*]

government. Unfortunately, we have to be extremely selective. In terms of pointing that resource at its most appropriate potential industry has to make some tough decisions. There will be a lot of companies out there who will be told they are not key industries. Industry will have to take that on board. I think that we and the DTI have to sit down with some broad guidelines which have come from the various trade associations—where perhaps they are going to earn their money for a long time—and make some critical decisions. We have to get some decisions from the trade associations who should understand their market place—electronics, aerospace and so on—better than the people in this room. We should take that broad-brush decision-making process from the DTI to the OST. Under the new arrangements there are clear people to talk to. OST should be part of that discussion.

Sir Gerard Vaughan

298. Going back to your point about the number of papers published, does not the solution lie in your hands? When people apply for jobs they think that the larger the number of research papers published the more likely they are to get the jobs?

(Professor Jones) It is also about the way in which those academics are going to get funds for the next year of study. The current systems in place mean that the number of publications is a very important part of their success.

299. You can stop that, can you not?

(Professor Jones) We can certainly do that; To me, it is all about persons. But if the academic system of giving grants and looking at the number of staff and students is based upon that, despite the excellent research that SPRU has done, then I feel it will be a self-perpetuating problem.

300. Perhaps we may now turn to the supply of adequately trained scientists and technologists. We are very worried not just about numbers but quality. The ABPI is on record as saying that you think the United Kingdom system is at fault?

(Dr Elves) In our industry we have little problem in recruiting people, for the simple reason that we have the economic force to do it: we pay them a lot better than the university system. That has to be a worry for the universities. The real issue for us is what we are seeing coming out of the universities at the moment, that is, scientists who are very good on the theoretical and conceptual side of science but have not got very much experience in how to do the science. We have organic chemists coming into our chemistry departments who have no hands on experience of chemistry at the bench until they get into the laboratory. That is where they discover that they do not really want to do chemistry any more. We have biologists who do not know how to handle animals.

301. To follow up what Mr Lester said just now about the poor calibre of people being taken on in the engineering field, Mr Edmonds, the union leader, said the other day that most people regarded government training schemes with contempt. Surely, the solution lies in your hands to an extent. You can apply more pressure, can you not?

(Dr Taylor) I would support what was said earlier. About one fifth of the staff in my laboratories come from continental Europe. We see very bright, able people who have had five-year rather than three-year degree training and who have breadth, flexibility and an ability to tackle new problems. I get very concerned when I hear people talking about having maybe two-year degree courses for engineering in the United Kingdom.

(Dr Brophy) As an industry we do things to broaden the experience and quality of the graduates that the system produces to make them more fit for our application. We rely on having the best possible product that the system can produce. Once we have a candidate we try to broaden his skill so he can understand the environment in which we are working.

Chairman

302. How do the pay and promotion prospects of a newly-recruited scientist, engineer or technician in your companies compare with the prospects of an accountant, marketing manager or even sales representative?

(Dr Richards) We do not pay our scientists anything like what they are worth. The pharmaceutical industry is perhaps from that point of view one of the best. Even so, in terms of potential career and maximum earnings it is not the scientific pathway which yields the most.

(Mr Lester) We start from very similar salaries but very quickly after that the marketing guy will outstrip the rest. The technical end will be in the middle of the range.

(Professor Jones) We feel that our industry is an exception in this regard. Scientists can and do command very high rewards. Many of us operate a dual ladder system either by route of science or management. The rewards which the scientist can get are commensurate with those that the commercial or financial side may offer.

(Dr Caton) In our industry the situation is that salesmen, marketing people and accountants are likely to achieve senior management positions in companies early in their career, whereas senior managers from the scientific side tend to be people who have been doing science at the bench for some years and will be older. That is a factor in the problem.

303. Is it not the fact that in Germany some of the great chemical companies are run by chemists?

(Dr Caton) Yes.

(Dr Brophy) We operate in the United States, Europe and the United Kingdom. In the United Kingdom there is a big disparity between what we as an industry pay our scientists at any level and what

[**Chairman** *Contd*]

they would be paid in academia. In the USA generally people are paid on a par or above what they would be paid in academia.

304. But you have created that state of affairs. Nobody has told you what to pay?

(Dr Brophy) We pay them a lot more than they would get in academia. I think that reflects the value that the United Kingdom applies to technologists in general, whereas in other countries academic scientists are held in high regard and that is shown in their pay packets. That creates a climate which is more attractive to industry in terms of R&D.

Mr Batiste

305. I appreciate that the situation you describe exists. What I do not understand is why you do not believe it is within your power to change it. You are now describing to us the classic situation where you have good scientists and technicians in short supply and you are having to recruit from all round the world to get people from other systems, whereas it seems to me that the core reason why law firms recruit scientists and engineers to become lawyers is because they are able to offer them more money. Why do you not do so?

(Professor Jones) I alluded to that in a previous response. Undoubtedly, because science is not given a high enough profile it is not seen to be an attractive area to be in. I also indicated that we had set out to correct that. The big swing was towards the city where the boom was taking place. A lot of young scientists went to the city. I am glad that science pervades a large sector of our community; it is healthy to have scientific thinking in that sector, but the swing has been too great. That is not the case today. That sector of employment is much less able to attract and have those high-salaried people in their employ.

306. That does not address the problem. The core of the problem is cultural. The problem with culture is the life expectation of a young person who is thinking of the career he wants to pursue. The one thing that people most concerned with British science and technology in industry can do is put up their pay rates to a level which will change the culture?

(Professor Jones) We have. We have talked to people at all levels, not only on the scientific and educational side but elsewhere, about the attractiveness of careers in industry. Some of us in this room are examples of the success of science in that regard. Certainly, in the pharmaceutical sector pay is very comparable with other opportunities in industry.

Dr Bray

307. Perhaps we may turn to the encouragement of industrial R&D in the United Kingdom. Can we start by trying to explore why research and development is more important in pharmaceuticals than any other industry? Is the intensity of pharmaceutical research and development within the United Kingdom greater than that in other competitive industrial countries? Is pharmaceutical R&D as a percentage of GDP greater in the United Kingdom than in Germany, United States, France and Italy?

(Dr Richards) I have a view but do not have the facts at my disposal.

308. Could you put in a note on that topic?

(Dr Richards) Yes.

309. We know from evidence from the APBI and elsewhere what the research and development expenditure is as a proportion of sales, per employee and so on. But is the position in pharmaceuticals particularly strong in the United Kingdom or is it general throughout the pharmaceutical industry?

(Professor Jones) What I can say is that the British and American bases of investment in pharmaceutical R&D have been success stories. It is also fair to say that in the past that was true also of continental European countries, in particular Germany and Switzerland. That is perhaps changing a little now. I have some figures which appear on page 33 of our submission relating to the support of the science base. They indicate the relative R&D expenditure in America, Japan and Europe.

310. But I do not think it gives the information in the form I asked for it.

(Professor Jones) We will provide you with that.[1]

(Dr Richards) If I may say so, the figures in the document show quite clearly that spending on R&D as a percentage of sales is much higher in chemistry and health than in other industries in all countries mentioned there, that is, the United Kingdom, Germany, Japan and the US.

311. I do not know whether you are familiar with the picture relative to other industries and the totals relative to those other industries. The particular question is how important this is as part of the national scene. Is the relative strength of pharmaceutical research in the United Kingdom due to the strength of the science base in biology in the past? Has that been a major factor?

(Professor Jones) I feel that both biology and chemistry are key factors in our success in innovative discovery. We are a classic example of taking good academic research and drawing it down into commercial research. I strongly believe that that is because of biology and chemistry not being over-directed but being given a confident basis on which to succeed.

312. Can you give us some idea of the timescales? For example, the popular view is that the double helix has been tremendously important and has been a great factor in success. In fact it has not been a major factor up to now?

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[1] See Minutes of Evidence p. 113.

[**Dr Bray** *Contd*]

(Professor Jones) I would suggest to you that anti-viral chemotherapy in which Wellcome have a certain interest is wholly dependent on our understanding of genomes and the basic structure of viruses. I suggest to you that the advances made recently in oncology are dependent on that.

313. But that is of recent origin?

(Professor Jones) Yes, but how recent is the discovery of DNA in terms of the life of science?

314. That is what I am trying to get at. What are the timescales between the basic science and its application to industry? As you say, genetics is tremendously important. The basic work was done 40 years ago.

(Dr Elves) That is a difficult question to answer because the response will vary according to different areas of biological science. For instance, the work in my company on the 5.H.T. (5-Hydroxytrptamine) area took 15 years of research, having discovered the importance of serotonin in biology and disease. It took that time to come up with the lead compound that could be developed. In other cases such as antibiotics the time taken might be relatively short.

(Dr Taylor) To balance the picture in case you think the life sciences are the only ones with very long periods of research, in the case of computing and mundane inventions such as the UNIX operating system. That was initially developed in about 1960 but came through to the commercial market place only in the past couple of years.

(Dr Brophy) The chemical industry has a range of product life cycles, all the way from heavy petrochemicals which may take 10 to 15 years from start to commercialisation to speciality chemicals characterised by a very fast response to the market place. That can be measured in months rather than years. I remind the Committee that the European chemical industry leads the world in chemicals. Within that the United Kingdom industry is a major player. We rely on R&D across all of the sectors of our own industry to be competitive.

315. On the question of timescales, is it true that they have been shortened?

(Professor Jones) There are elements of the time of exploitation which are dependent not on the actual discovery but the validation of the process. We have very clear evidence that there has been a lengthening of the time from the act of discovery to the commercialisation of the product because of the additional studies and tests that necessarily have to be done internationally to confirm the acceptability of the product, not only to our satisfaction necessarily but, importantly, to various governments of the world. I think we are reaching the end of that and those times are now fairly well organised.

(Dr Richards) As a point of information, I was in the laboratory when the structure of DNA was worked out, so I have a point of view and an opportunity to see what has been happening. I can tell you that we now know more about health and disease in the relatively short time since that discovery than we learned at any time beforehand. The pace of things is moving rapidly. The timescales are very short. We are concentrating on discoveries made in the science base in the early 'fifties. What I think industry has managed to do is manage the process of utilising science to produce products. I think the Committee should not concentrate too much on invention but on the continuum. What is important is the capability of industry to manage good ideas and bring them through to products.

316. To characterise the particular management and investor position in pharmaceuticals, would it be true to say that by and large within the industry you know each other's sales by product and prices and attend the same scientific meetings? You also know broadly the areas in which you are currently carrying out research, and you also know each other's long-term plans. There is a great deal of intimate knowledge of what the competitive game is?

(Professor Jones) Yes.

Chairman: You may have a common customer base of considerable size.

Dr Bray

317. Yet all of that is quite consistent with strong IPR protection?

(Professor Jones) IPR has been a problem to us, and still is in many countries of the world, in the sense we have not gained the maximum benefit from the total term that is normally available. The length of time it has been taking to bring our products through necessarily with various government approvals has shortened our time of exploitation. In the European scene that has been changing of late but we obviously have some way to go.

318. You have said that the science base and the fact that the management are science-oriented are important matters to you. A further feature of pharmaceuticals is that there is a very high degree of product testing over and above that actually required by the market in the sense that you could sell untested drugs and leave the public to protest afterwards if something went wrong?

(Professor Jones) I think ethics would be involved![1]

319. That is recognised in regulatory systems and it is a very important factor in the work you do. You accept that you ought to do it?

(Professor Jones) Yes, but the consistency of those systems on an international basis leaves something to be desired. The harmonisation of international requirements is an essential part of it because we must be driven by the largest and not smallest requirement.

320. A further factor that is relevant is that you give an undertaking to the Department of Health on

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[1] See Minutes of Evidence p. 113.

[**Dr Bray** *Contd*]

the amount of research and development you will do as a condition of the pricing of drugs that you sell to the National Health Service?

(Professor Jones) I think there is negotiation on the return on investment rather than an undertaking on the amount we will do, but in many ways it can result in that type of understanding.

321. Can you let us have a note specifically on that both from the point of view of ABPI and the point of view of individual companies, if that is separately known? I am interested in knowing how the formula actually applies to those companies.

(Professor Jones) We will undertake to send you a paper on the PPRS scheme as it operates and as we see it as different companies.

322. Do you over-fulfil the commitment?

(Professor Jones) As I understand the scheme—and I have to say I am not an expert in this particular area since it relates very much to the pricing of pharmaceuticals and not the R&D side—in order to obtain the right balance between investment and research and the price of pharmaceuticals there is an equation worked out together with the company that satisfies the needs both of the Health Service and the investment requirements of the company. We will send you a note.

Mr Batiste

323. Does the relative success of the pharmaceutical industry in Britain depend to a considerable degree upon having one very large and dominant customer products in the United Kingdom that can provide a very substantial domestic market in a way that perhaps other countries cannot?

(Dr Elves) The pharmaceutical market is largely outside the United Kingdom. This country represents a very small percentage of our market, which is why we are big exporters.

324. What we are looking at is the motivation of multinational companies in setting up research and development facilities in the United Kingdom. What features would make the United Kingdom attractive for bringing multinationals into the United Kingdom? To what extent do those exist at the present time?

(Dr Taylor) There are a number of different factors. First, there is the question of getting the best climate of engineering and science excellence that we can. The second issue is often the coupling of that aspect with local market places in the United Kingdom and Europe to get a much closer understanding of what is happening there. The third issue is one of communications, environment, infrastructure and support in general. Again, I think the United Kingdom is still an excellent place for people to carry out strategic lines of research activity.

325. You have not mentioned tax in your list.

(Professor Jones) Tax is a component, but undoubtedly the reason why a lot of inward investment takes place in our sector is because of the talent and quality of science. That is paramount in biology in chemistry, but tax is not.

Dr Bray

326. Your strategic decisions in both chemical and pharmaceutical research are necessarily very long term. It takes a long time to set up a research facility and to produce results. Is it not a feature of international tax regimes in relation to research and development that they have been made variable?

(Professor Jones) Yes.

327. That is so in the United States and Europe but in Britain they have been non-existent.

(Professor Jones) I cannot answer that.

328. If the sustained position was one in which in real terms research was 50 per cent more expensive to do in the United Kingdom than in Germany or the United States would that be a significant factor in your industry?

(Professor Jones) Speaking for a company based in this country with a big investment overseas—in America and Japan—that is a rather different question from one where one wants inward investment in this country. Lots of large American, European and now Japanese companies are putting effort into investment in this country. I do not think it unreasonable to suggest that if the tax position became disadvantageous they would seek to do science elsewhere. Why should they do it here?

(Dr Taylor) I have been contacted over the past two years by various international companies who say, "We are thinking of coming to Europe. You have been in Europe in the past seven years doing research. What is your advice?" Their main concern is much more to do with whether, if they come to Europe, the United Kingdom will be well connected to Europe. It is not primarily a question of tax. I think tax comes into it to a greater extent when one comes to look at manufacturing costs.

Mr Batiste

329. They do not want to be seriously disadvantaged in coming here. The reasons for coming here would be positive ones, not tax reasons?

(Professor Jones) Yes.

Sir Trevor Skeet

330. With the single European market coming into operation on 1 January next year, are they not coming to the United Kingdom because it is already in Europe?

(Dr Taylor) Yes, but as newcomers about to make that decision they are slightly more concerned about the European policy dimension than they would have been three years ago. They are asking

[Sir Trevor Skeet *Contd*]

whether we are clearly committed to it or whether, if they decide to come here, potentially they will face a disadvantage in terms of being at the centre of all things European.

Cheryl Gillan

331. Surely, as far as R&D is concerned what is critical is a tax regime which is favourable compared with all other countries in the EC?

(Dr Taylor) I think that the overall manufacturing cost envelope is quite good in the United Kingdom compared with, say, Germany. Germany has quite a serious situation.

332. There have been plenty of demands for government, research councils and particularly universities to do more to encourage technology transfer, and we hear that much has already been done. For example, the regional technology centres have given help to small and medium size enterprises. There are lots of industrial liaison officers and plenty of schemes around to encourage industry to collaborate with academia. Why are those measures apparently so ineffective? Why is there an apparent communications gap, and how do you think it could be filled?

(Mr Cooper) First, there is a problem of supply, push and demand. The whole argument centres on organising the supply. We are still dominated by it. We need to change the atmosphere so that the whole thing is demand rather than supply led. A lot of the questions put out by OST when they asked for comments on the White Paper dealt with the supply rather than demand side. Somehow we have to get over that problem. The second point is that we are still not educating our managers very well. Very few managers in their training deal with the process of innovation, what it is all about and how to assess risk when investing in R&D. We have to look at our management training and skills and get them to emphasise innovation more, what it is all about and how to assess risk.

333. What about the reverse—taking your scientists and giving them more management training in areas such as marketing, because that would help you with the "low value" in terms of salary that you seem to place on them?

(Mr Cooper) Yes. We also have a slight problem with university education. We are still teaching mechanical engineering, civil engineering and chemical engineering. Industry really does not want those people any more; it wants engineers with a much broader base who understand the sorts of things you are talking about; it wants systems engineers rather than engineers dealing with one very narrow subject.

(Mr Lester) I should like to emphasise the importance of having a strategy that is understood by the country. Therefore, the universities would be a very important and big step. The universities would begin to understand where their research would automatically fit in with the way industry was going. Secondly, it is important that the universities get much closer to industry and vice versa. Progress has been made in that regard. If one takes Imperial College, Sir Eric Ashe is very much in favour of meeting industry and trying to turn what he is doing into useful products, not just pure R. We held a meeting at which eight to 10 of our R&D directors sat on one side of the table and his experts sat on the other. After a full day of explaining what we were looking for in terms of our market and what research was going on we found just one overlap.

Mr Miller

334. The interchange of ideas in any enterprise is obviously very important. One of the experiences I have had in relation to many of the companies represented here is that, contrary to Professor Jones' remark "Yes, scientists can command very high salaries", they do not necessarily command places in the managerial structure. That creates a number of problems. Interestingly, in relation to one of Dr Elves' companies some brilliant pharmaceutical development has come into production as a result of the exchange of technology from the engineering sector in relation to a slow-release drugs. Without the engineering exchange the product would never made it to the production line. I want to explore the importance of technology transfer from outside as well. Independent research organisations see themselves as one of the prime sources of technology transfer. How useful do your members find it?

(Mr Cooper) I run one of those organisations. I have to say that the turnover of my contract research organisation is £7½ million. Of that 85 per cent comes from doing contract research for industry. We were formed in 1947 and have grown since. We would not be here if industry did not find us useful; they would not purchase the services. We are in one sector. It is worth saying that in the United Kingdom there is a strong independent sector. There are over 40 independent research and development organisations with a combined income of about £300 million. That is more than universities earn from industry. We employ about 10,000 engineers and scientists. The role of the independent sector is very important to the United Kingdom industry and is probably underplayed.

(Dr Caton) I am very interested in the area of technology transfer because it is part of my job. It is improving. There is no doubt that we are doing more in this area. I do not think we have been able to identify more than a fraction of the opportunities for moving technology about in this country to places where it can be taken to the market. I include in that company-to-company transfers. I believe that within companies there is technology lying on the shelf because it may not of direct interest to the particular company. That could be taken forward elsewhere. I have limited personal knowledge of that. As regards universities there needs to be a lot more searching out of what is realistic. Sometimes university people

[Mr Miller *Contd*]

tend to be a little naive about the commercial importance of some of their work. It needs to be sifted and looked at in a strictly business fashion. It is a very skilled job that requires a good deal of commitment. I think companies can aid that process by appointing people specifically geared to doing the job of technology transfer. Most R&D and technical managers are concerned with running their own departments; they are not really taking technology transfer seriously, in my view. In addition, there are some areas of technology around that are at an early stage and have commercial potential perhaps some years ahead but really are not at a stage where industry can take them seriously. It may be the DTI should address limited funding to encourage that. For example, it is happening in the LINK scheme.

Sir Gerard Vaughan

335. Again, it lies in your hands, does it not? The kind of comments you are making have been made by people for some years but nothing has happened?

(Dr Caton) A lot is happening.

336. Why are you not making more progress? I was very worried about what Mr Cooper said about the narrow bands of training. I cannot see the point of taking a research scientist and teaching him to do marketing, but I can see a point in giving him wider links. Surely, you talk to the Committee of Vice Chancellors. You do not appear to be making much progress.

(Dr Taylor) Some places are. For example, if you look at our applied research laboratories you will have seen their role changing quite a lot over the past five to 10 years. It is only half to do with pursuing particular technologies for the sake of those technologies; the other half is about exploring problems that can be solved from the customer point of view, product point of view and application point of view. Putting those two things together, helping to decide what a company should do and what technologies it needs to meet that requirement, is now a perfectly proper part of what an applied research lab in industry should do. In that sense engineers and scientists coming into such an environment respond very well, not to being sent off to do marketing but to developing an awareness of customers, determining what the customer needs and bringing those problems back to the laboratory and saying, "Maybe we can do something about that that would be interesting". The other role that a lab like ours has is to take those problems back to academia. We have had a very good response. We are a member of the Imperial College Computing Forum which tries to get that kind of dialogue going. People in academia respond extraordinarily well when one comes back with a problem that they did not know about and they can sink their long-term "curiosity" teeth into for the next five or 10 years, perhaps to come up with some surprises.

Sir Trevor Skeet

337. Do you think that more use could be made of specialist companies operating in this field? We have just floated off the British Technology Group. Another one that has caught my attention is AEA Technology. Have you found any way in which we can get more out of the Ministry of Defence? This is where the R&D is being done in a very big way and has disappeared into the sand.

(Dr Richards) All the arguments we have heard from Members of the Committee in the last few minutes point to the fact that we have not got the balance right between supply and demand. We have any amount of technology which is not being transferred because it is inappropriate. The LINK scheme is the only forum of which I know in which there is proactivity and identification of objectives that are needed by industry and can be supplied only by academia. There is also a co-operative activity which is equally supported. It has teething troubles but it certainly has the potential of solving problems and doing the things that are needed in a way which will make them transferable and turn them into products.

Mr Miller

338. Recently, I saw a suggestion in the electronics sector in relation to a company that inwardly invested in Europe and chose France as the area in which to locate. The basis of their decision was the success of technology transfer in that particular field in that country. Would you like to comment on that? Do you think that perhaps in that field France are better than we are?

(Mr Lester) For my sins, I once ran a French company. It is the only company in which I have been involved where all the engineers were publicly funded. There was no engineer being paid by that French company. The point I am trying to make is that perhaps France can be an attractive country in which to invest from the United Kingdom in a particular field where the French have made a major investment. They protect that very strongly and it is not easy to gain access.

Dr Bray

339. Are the independent research and technology organisations still in favour of the original concept of the Faraday programme?

(Mr Cooper) Do you mean by that the latest report that has come from CEST?

340. I am referring to the innovation working party?

(Mr Cooper) Yes, broadly.

Chairman: Let us move on to the question of government funded R&D.

Mr Powell

341. We have been considering a lot of analyses this morning. As Dr Vaughan has just reminded us, much of this has been going on for years and very little progress has been made; we have just been going round and round in circles. It is implicit in what you say that you are asking for a much stronger role from government, and maybe a much stronger role than the Government either wishes or is capable of conceding. Much government research and development funding at the moment goes to advance specific programmes of its own departments, whether it is transport, health or whatever, and is not developed to a more strategic and focused concept than their own particular programmes. Are you asking that there should be a shift in the way government approaches it away from its own programmes to something that is more strategically directed? Is it practicable, and how would it be achieved?

(Mr Lester) The reason we are going round in circles is that there is not a well understood plan. The reason we have not made the maximum use of technology and investment powers is that we have used a shotgun approach. We are now talking about shooting with a rifle. Secondly, there has been an inability on the part of government to help to co-ordinate and make decisions. It is a cop-out. Other governments do it quite successfully. There needs to be some education of the government and of industry and also a change of attitude. I do not see why this Government, or whichever government is in power, cannot reach that state.

Chairman

342. Would you agree that government effort is too unfocused and it might be helpful to have fewer and better funded initiatives?

(Mr Lester) My glib answer is that that is absolutely correct. That is the whole point. Again, once industry has honed down with the DTI and OST the basic plan other government priorities will have to be taken into account.

(Mr Cooper) I agree with that. There is also lack of consistency about government policy. We have been talking about different investment horizons today. We need a consistent approach over a fairly long period.

(Mr Lester) Over the past few months one of the encouraging things is that all parties have made claims and statements that the country needs a manufacturing strategy and they want to back industry. The Labour Party had a good manufacturing strategy in their last proposals. If all parties believe in it whoever is in government over the next 20 years—and it will take that long for full success to come through—that will reassure industry and the investment community to invest in that game.

(Professor Jones) Because the OST is new in concept and has no baggage in that regard we see it as a golden opportunity to carry out that very function. In practical terms, I feel that that could be the place where a restructured advisory board with all the elements of a science base that we talked about earlier could determine policy. From that the individual sectors could be dealt with by groups that are formed for a specific activity, but at least all of those parties, whether it be the DTI, DES or others, could be focused through that single policy activity.

Dr Bray

343. You are not saying that the science base should be directed in terms of what scientists actually do?

(Professor Jones) Given that the policy is created in terms of where the science base should seek to move, I think it would be up to the OST through expert funding mechanisms to allow the constituents representing that policy to determine how those elements are put together. I think it should be managed in that way.

344. But is the direction of the science group a peer group-determined activity as it is broadly within the research council structure, or should it be a government determination?

(Professor Jones) Ultimately, I believe that the Government and Parliament will have the final say, but in terms of the advice and creation of the policy to suggest to government surely this is a good way of doing it. At the moment it is spread so thinly across so many different areas that it is difficult to see where it is policy and not tactics in each Ministry.

Mr Powell

345. We come back to the crucial words that the OST has itself used to describe how it sees its function, that is, to be in the nature of an overview, not in the nature of directing, being in charge of it and making decisions. It is a question of monitoring it; it wants to take an overview. It is presided over by two fellows of All Souls who are used to the senior common room atmosphere. That is not how you view the OST?

(Professor Jones) In my introductory remarks I talked about co-ordination, control of funding and management. In my mind, I have very similar analogies with the way I conduct my industrial activities.

Chairman

346. And you are not a fellow of All Souls?

(Professor Jones) No, but I have dined in there!

Sir Gerard Vaughan

347. Have the witnesses any further comments to make about government policy or lack of it on applied research and near-market research funding?

(Mr Cooper) We have a problem with the current policy when it comes to smaller companies. We have 95 per cent of British companies employing less than

[**Sir Gerard Vaughan** *Contd*]

20 people. To have a policy which says that government will support only research and development that is far from the market and generic in nature means it is very difficult for even medium size companies employing 300, 400 or 500 people to take the long-term view that the Government say has to be applied to get any research grants. It is all right for the larger companies but not for the smaller ones. In my own organisation we find it is very difficult to get small companies to collaborate on projects supported by DTI funds.

348. You find that policy damaging to small companies?

(Mr Cooper) Yes.

349. Do you think there has been any change or softening in government attitude recently?

(Mr Cooper) There has been a more pragmatic view of this. I think that the Innovation Unit of the DTI has been doing some very good work in the past year or so.

(Dr Caton) We take the view that the prime role of government should be to support basic research. We would not want to see too much of that taken away to support near-market research. We would not want to see hard and fast lines drawn on the basis of what has just been said. I would like to reinforce my earlier point that the middle ground of research is often forgotten, that is, technology in universities that has a long-term commercial potential. It is not blue skies research. I think that more attention needs to be given to that to help take it forward to meet industry's requirements.

(Mr Lester) Please understand the difference between the pharmaceutical world and blue skies research. We need money now to be invested in products that we can sell tomorrow morning, not in five years' time.

Chairman: Let us turn to the issue of intellectual property.

Mr Williams

350. I want to address my question to the CBI. I was looking at the latest edition of *CBI News*. That contains a table dealing with the number of patents taken out by companies in Britain and an international comparison. The number of patents has declined in the past five years whereas internationally it is increasing. The publication gives quite startling statistics as to the average annual number of patents per 100,000 inhabitants. Allowing for population differences, the numbers are as follows: Japan, 43; Germany, 28; United States, 19; France, 15; Britain, 7.7; and Italy, 0.3. Why is it that when one compares Britain with Japan, Germany and the United States the number of patents taken out here is way behind?

(Dr Richards) The key word is "quality". If one looks at the sustainability of patents once issued and their importance in protecting products the geographical comparison to which you refer would not be so startling in relation to the United Kingdom.

Chairman

351. It is not a weakness?

(Dr Richards) I could point to reams of patents from Japan throughout wide areas of chemistry. Such patents always begin with "has anti-viral properties".

(Mr Cooper) Another point is that copyright is being used far more in the United Kingdom than patenting. We are using that for computer software. If one looks at the figures for copyright one may find that they have been increasing.

(Mr Lester) I think that the statistics are a worry. In the engineering industry, which is under extreme pressure because of the recession, applying for a patent is expensive. We do not encourage our engineers to apply unless we think we have an excellent patent. As regards a lot of patents that are put up, we look at them and if they are marginal we do not apply because they can be very expensive. The Japanese do not take that approach; they patent anything that they think will give them a slight advantage.

(Dr Taylor) I would strongly support the claim that cost is an issue. I think that something else worth looking at is the extent to which intellectual property protected by whatever means is a feature in alliances and partnerships being struck between companies. In our sector internationally there are a tremendous number of alliances and partnerships going on. The intellectual property that a particular company brings to the table to trade in those negotiations is getting more rather than less important.

352. Could the system be improved to cope with that problem, or are you reasonably satisfied with the system as it exists?

(Dr Taylor) I think the system is reasonably all right though expensive.

353. If it provides protection it is not a bad thing?

(Dr Taylor) Yes. It may not relate to something which you intend to take to market; it may be something you will use in striking an alliance with somebody else.

Mr Batiste

354. I am not entirely clear whether you are saying that focusing more on the quality of the patents than the quantity is a good or bad thing in industrial terms for the future. You have described very clearly the difference in attitude between ourselves and the Japanese, that is, we may take out a core patent and leave it at that and others will take out subsidiary patents. Is our industry weakened

[**Mr Batiste** *Contd*]

because of that? Should we be going down the Japanese route and doing a lot more of secondary patenting?

(Mr Lester) If one looks at it in financial terms industry has perhaps better things to spend the money on. If one had the luxury of being able to generate more patents it would be a nice thing to do. Speaking for my own company, we patent those areas that we think are very important and essential. We would like to do more but we cannot.

(Dr Taylor) I think it depends on the extent of one's ambition. If one is intending to become a global player in a particular market place or product one needs to take a much more aggressive attitude.

355. It is a form of advertising, is it not?

(Dr Taylor) Yes—and a form of protecting one's ability to operate on a larger scale.

356. That was your point in relation to joint ventures, that you were marking your ground to look at potential partners rather than excluding people who did not join you in partnership?

(Dr Taylor) Yes.

(Professor Balmford) I wish to reinforce the last point very strongly. In joint ventures one brings to the table patents for currency to establish one's position, hoping to take away from collaborative research which leads to projects that part which you wish to manufacture and make money out of. In that sense they are extremely valuable forms of currency.

Chairman: Let us turn to the last aspect: international aspects.

Cheryl Gillan

357. I have been receiving conflicting messages in the submissions dealing with international programmes. AEA Technology maintains that "on the whole" national and international programmes "are reasonably complementary", whereas EEF say, "We do not get optimum benefit from international collaborative programmes. . ." Referring specifically to the EEF, I want to ask a general question—and perhaps Mr Lester would like to field my question —about the attitude of industry to the Framework programme and the need for international co-operation on R&D generally. The EEF memorandum suggests that government has almost delegated its responsibilities to the EC. Could you expand on how you would like to see the system work in the light of your criticisms?

(Mr Lester) One has to return to the fact that in engineering one is trying to develop products in a two to three-year timescale—preferably one year—to get them to market. The important point about collaboration is that it slows down the process to the point where the time taken is usually doubled. The other point is that because one cannot patent or copyright everything one is often giving away ideas and fundamental technology. All things being equal, if in the United Kingdom we could develop something much quicker for the market so that the market place and our competitors had not passed us by that should be the priority, whilst recognising that obviously there were certainly cases where collaboration particularly on pure R might be advantageous.

358. In addition to that, do you think there is anything else that could be done to make international collaborative programmes more worthwhile?

(Mr Cooper) Yes, I do. Some of the problems we have highlighted about our national policy are reflected in the third and fourth Frameworks. There is lack of clarity about why we are doing it. The aim is very unclear, apart from the objective of improving European industrial competitiveness in accordance with Article 130 of the Treaty of Rome. That needs to be clarified in the same way that we need to clarify what the United Kingdom is doing. There are problems about how SMEs can access some of those programmes. If one looks at the access gained so far it has all been dominated by large companies. The little guy finds it extremely difficult to deal with it. It is takes a long time to get a decision; it is bureaucratic; it does not pay very well, and so on. There are lots of practical problems to be dealt with.

Sir Trevor Skeet

359. International collaborative efforts, whilst being very important, happen to be very expensive and time-consuming. The European fighter aircraft seems to have fallen on its face. The subscriptions to CERN total £55 million a year; radiological facilities amount to £42 million a year; space has £20 million a year. There are also efforts being made in private undertakings. Is it worth the international collaboration? Surely, can it not be made much more effective than in past years?

(Dr Richards) It is my belief that the United Kingdom has not put enough effort into the formative and planning stages and the identification of programmes under the earlier Framework programmes. We did not take them as seriously as we should have done. As to the fourth Framework programme, I think that those efforts have been made and I hope we will see the results. There are some areas of R&D which cannot be done on a national basis, and indeed are very much better done in a community such as the EC. It is the separation of those things we wish to do nationally and those we wish to do internationally that should be the prime focus.

(Mr Lester) It comes back to the need for a strategic plan.

360. One of the big anxieties we have is that in CERN we do not get many of the contracts back; they seem to disappear to the Germans and French. Is there any way of ensuring that that does not happen, perhaps by better co-operation?

[Sir Trevor Skeet *Contd*]

(Dr Richards) Yes. It has happened because we were not in at the forefront of discussion and lost out all along the line.

(Dr Taylor) Turning for a moment to the Framework programmes, I think it is worth paying attention to what has happened within the Commission over the past few months. They have been under a tremendous amount of pressure to demonstrate value for money; they are rapidly bringing through new programmes—critical technology programmes and so on—and becoming much more pragmatic and less directive in terms of inviting big companies to come and make proposals. There is some intensive activity going on at the moment.

(Dr Elves) The pharmaceutical industry has not been active in working with the EC and its organisations in collaborative research largely because it wants to get collaborative efforts up and running. Most of these exercises are intensely bureaucratic and can tie up a law department for quite a long time. That does not mean to say we do not collaborate with colleagues in Europe. My company is now putting in considerable effort to develop collaboration with universities and research establishments on the continent.

361. Dr Elves and Dr Taylor, are you suggesting we do what the French do and lean heavily on industries and try to give them a push?

(Dr Elves) First, I think we could be pushed a little further if it was easier to see where we could collaborate within the programmes. That is coming. Secondly, the whole thing should be less legalistic and bureaucratic.

(Professor Balmford) I think that the aerospace sector of the manufacturing industry has found the European Commission programmes very successful. They have put a lot of hard work into ensuring that the companies get together beforehand and produce effectively a strategy that has been discussed with the appropriate directorate in the Commission. For example, programmes like the aeronautical section of BRITE/EURAM are regarded by the industry as very important. You also have to have the currency to take into those programmes, and a national programme is the basis for that. On the defence side there is a very different situation. The Government have not had dialogue with industry as to what a European collaborative research programme such as EUCLID should consist of. It is getting a little better but it is nothing like as good as the civil side.

Dr Bray

362. There have been some fairly important areas of European policy where the pharmaceutical and chemical industries have been very active—for example, recent work on the release of genetically engineered organisms. A working party was set up to look at it. Is it not logical that that kind of issue should be backed by European research programmes?

(Dr Elves) I think that the areas you are talking about are largely regulatory areas where our having an input and providing expertise in formulating those policies and regulations is very important.

363. But is not the consequence of those regulatory regimes emerging without a research base that some will be quite absurd?

(Dr Elves) Some of them were, because in some cases we were not consulted.

364. But if there is a research climate behind the European institutions it greatly increases the chance of getting sense?

(Dr Elves) We would agree wholeheartedly.

365. For example, you have been successful in EMBO. Why should you not do more?

(Dr Elves) We have to be consulted.

(Dr Brophy) We do not have large European collaborative programmes in my company, but when we do go into Europe we do so to make up for some of the shortcomings at home. For instance, if we want to tie into an academic science base—certain areas are of key importance to the chemical industry and are growing in Europe and elsewhere but receding in the United Kingdom—we are obliged to become Europeans in that sense. My colleague mentioned the complexity and bureaucracy involved in these programmes. I think that a lot can be learned from the EUREKA scheme which is more lightly staffed by people who are on secondment. That seems to be more responsive to industry. There may be some programmes where Europe has a real collective interest in the chemical industry to retain its place in the world, but I do not see a lot of discussion and dialogue leading to a sensible allocation of effort.

Mr Batiste

366. As a point of clarification, I completely understand the support for a European endeavour where it makes economic sense: for example, the European Space Agency where many of the projects would not have happened other than on a collaborative basis because the sums involved were so large. As far as other projects are concerned, I was not quite clear whether you felt there was a role for European programmes that might be longer, more complex and more bureaucratic as a consequence of being European and there was a need to act as a catalyst to bring together collaborators when perhaps it could be done on a national basis. I was wondering whether the effort required to provide that catalyst was itself worthwhile. I was not quite sure of your view on that.

(Dr Taylor) There are some areas where that is extremely valuable and they often have to do with forming open standards or other things that enable a new market to be created. If one looks at some of

[**Mr Batiste** *Contd*]

the telecommunications activities which have been organised by Europe over the past few years one can see some excellent results.

(Professor Jones) A classical example of that is emerging right now in the mapping of the human genome. The state of that international research is such that there is an imperative to ensure we know what the European, United States and other country components are.

(Professor Balmford) In the aerospace sector there are a number of projects which are going to come to fruition as collaborative projects. They form the basis of a good start on collaboration in a successful project. We view that as being essential.

Dr Bray

367. To be clear about the institutional aspects, is it not a fact that the human genome organisation is basically the creation of leading researchers in the field and not a bureaucratic invention by international organisations?

(Professor Jones) I think that supports the view I expressed earlier, that in the end it is about individuals and is curiosity-driven but the fabric has to be in place to allow those researchers to do their work.

368. But in a narrow sense there is no EC support for the human genome programme?

(Professor Jones) Not in terms of the funding bodies that are conventional in European terms. They tend to come through quasi-charitable organisations. I feel the time has come to ensure that we know where in Great Britain the overall contribution is going to be and how it may be exploited to our benefit and that of humanity.

Chairman: The time has also come to conclude this session. The Committee is most grateful to representatives of the CBI, Engineering Employers' Federation, the Chemical Industries Association and the Association of British Pharmaceutical Industries for coming here this morning and giving their time in answering our questions and promising to provide additional information.

Letter to the Clerk of the Committee from Dr Kipling, of the Association of the British Pharmaceutical Industry (24 November 1992)

During the meeting of 12 November, the Association agreed to supply a note to the Committee on the operation of the PPRS (Pharmaceutical Price Regulation Scheme). Information was also requested on pharmaceutical research and development as a percentage of GDP, and whether it was greater in the UK than in Germany, France, Italy and the United States?

Some general information on the operation of the PPRS as seen by the ABPI is attached. I am sure that the Committee will appreciate that it is difficult for me to give the views of any individual company operating within the Scheme.

I would also like to take this opportunity to bring to the attention of the Select Committee the Association's concerns over Government's proposals to extend the Limited List of medicines not available to NHS patients. Brief comments on this matter are attached, and the Association would be willing, if required, to provide additional information on the likely implications of this development for research in the UK.

The Association also feels that it needs to make a comment on a point (Question 318) raised by a member of the Committee, i.e., "**A further feature of pharmaceuticals is that there is a very high degree of product testing over and above that actually required by the market in the sense that you could sell untested drugs and leave the public to protest afterwards if something went wrong?**"

Such a statement indicates a lack of understanding of the considerable regulatory processes that are in operation worldwide. The pharmaceutical industry is committed to the search for new, more effective, and more safe medicines. The industry is, quite rightly, the most regulated industry, with such bodies as the UK's Medicines Control Agency, the US FDA, the Japanese MHW and the European Commission's CPMP all playing a major role in helping the industry to ensure that the product that reaches the patient is one of sufficient quality, safety and efficacy. It is inconceivable that the approach put forward by the member could ever be considered by the industry, and we were somewhat surprised that such a proposal was made.

(1) PHARMACEUTICAL R&D EXPENDITURE AS A PERCENTAGE OF GDP (1991)

The table below summarises the current situation:

	R&D Expenditure US $ million	R&D Expenditure as a percentage of GDP[1]
Germany	2,316	0.15
France	1,957	0.16
Italy	1,250	0.11
Netherlands	274	0.10
UK	2,215	0.22
Denmark	215	0.16
Spain	237	0.05
Austria	37	0.02
Switzerland	1,192	0.52
Sweden	569	0.24
Norway	55	0.05
Finland	67	0.05
USA[2]	9,200	0.17
Japan[2]	3,931	0.12

Notes:

[1] Gross Domestic Product at market prices.

[2] Provisional figures for Japan and the USA.

Source: EFPIA.

(2) THE PHARMACEUTICAL PRICE REGULATION SCHEME (PPRS)

(i) The UK system of price regulation was introduced in the late 1950s and was known as the Voluntary Price Regulation Scheme. The Scheme was neither "voluntary" nor was it a price regulation scheme, but a profit regulation scheme. The name of the scheme was changed to the Pharmaceutical Price Regulation Scheme (PPRS) in the mid-1970s, but this is still an inaccurate description of the process.

Members of the Select Committee will be aware that the Department of Health announced on 12 November that it intends to renegotiate the PPRS.

(ii) The objectives of the PPRS, as negotiated to operate from 1 October 1986 are:

- To secure the provision of safe and effective medicines for the NHS at reasonable prices.
- To promote a strong and profitable pharmaceutical industry in the UK capable of such sustained research and development expenditure as should lead to the future availability of new and improved medicines.

- Encourage in the UK the efficient and competitive development and supply of medicines to pharmaceutical markets in this and other countries.

(iii) The Scheme applies to all companies supplying National Health Service medicines which are prescribed by medical or dental practitioners. Generic medicines, whose price is determined by the Drug Tariff are excluded, as are over-the-counter (OTC) medicines, together with the sales of medicines derived from a private (non-NHS) prescription.

(iv) Each company with sales to the NHS of more than a particular sum has to submit Annual Financial Returns. These annual returns cover the overall sales to the NHS and the costs incurred such as manufacturing costs, general administration costs, promotional expenditure, and research and development expenditure. Profit is determined on a cost plus basis.

(v) The NHS sets each company its own maximum profit margin, expressed as a return on capital (ROC). The reasonableness of the return on capital earned by individual companies *in home sales* of NHS medicines is a matter of negotiation within a published range (currently 17-20 per cent) having regard to the nature and scale of the company's relevant investment and activities, and associated long-term risks. In practice, the actual profitability of the pharmaceutical industry on UK sales is extremely modest. In 1991 manufacturers medicine prices to the NHS rose by only 1.7 per cent, while general inflation was running at 5.9 per cent.

(vi) The level of support for *Research and Development Expenditure* is negotiated individually with each company. In order to offer stability, and in keeping with the Government's expenditure planning and normal commercial planning and budgeting arrangements, companies are given a firm indication of the level for the forward year, and a provisional indication (subject to confirmation) for the following two years. The level will be negotiated in the light of:
- The UK pharmaceutical industry average spend on R&D expressed as a percentage of sales.
- The overall pattern of the company's investment in the UK.
- The company's worldwide spend on R&D as a percentage of sales; this will be especially significant in assessing the allowance due on R&D costs incurred outside the UK. Except where a company's expenditure is significantly above industry averages, the R&D allowance in respect of aggregate UK and injected costs will not normally be less than the company's worldwide R&D expenditure as a percentage of worldwide sales.

In establishing the PPRS the UK Government's intention was to ensure a fair price for NHS medicines and a suitable return for UK-based companies, recognising the benefits they bring to Britain in terms of new medicines, exports and home employment. A recent analysis of the top 50 best-selling medicines world-wide showed that 31 per cent of all sales were for UK innovations. (USA 42 per cent, Japan 8 per cent, and the rest of Europe 19 per cent).

For every £1 of profit pharmaceutical companies make on home sales to the NHS they spend £4-5 on R&D. Capital investment is over and above this figure.

(3) IMPLICATIONS FOR THE UK PHARMACEUTICAL INDUSTRY OF THE PROPOSED EXTENSION OF THE LIMITED LIST

The Department of Health has announced a proposed extension of the Limited List, which was introduced in 1985. It is understood that many products, from a further ten therapeutic categories are to be excluded from the list of products which will be allowed to be prescribed on the National Health Service. The Association believes that an extension of the Limited List will have serious implications for patients, doctors and industry. Reducing the number of NHS medicines will threaten jobs, exports and research investment in the pharmaceutical industry.

The proposed measure will seriously inhibit research into those therapeutic areas covered by the limited list. The industry will not risk the expenditure on R&D in the UK on new products that may not be added to the approved list for NHS reimbursement. This may lead to the cessation of research programmes in the UK, with subsequent job losses.

Past experience has shown that the introduction of limited lists has reduced investment by the industry into new and better treatments. No new product licences have been issued for *innovative* new medicines for use by NHS patients in the seven therapeutic categories concerned since the introduction of the list in 1985. Research is the life-blood of innovation, and without innovation the UK-based pharmaceutical industry, its international competitiveness and export performance will be substantially damaged.

We trust that the Committee will give full consideration to these points as it reviews the factors affecting the support of scientific research and development in the UK.

WEDNESDAY 18 NOVEMBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mrs Anne Campbell
Cheryl Gillan
Lynne Jones
Mr Andrew Miller
Mr William Powell
Sir Trevor Skeet
Mr Alan W Williams

Examination of Witnesses

PROFESSOR WILLIAM STEWART, FRS, FRSE, Chief Scientific Adviser, MR ROBERT FOSTER, Under Secretary of State, and MR DAVID WILKINSON, Under Secretary of State, Office of Science and Technology, examined.

Chairman

369. Professor Stewart, you are very welcome. You are welcome at all times, as you know; we have had the pleasure of meeting you before in this Committee, but you are very welcome today with your two colleagues, whom I am sure you will shortly introduce. Our Committee is known to you, although we have two new Members since I think you met us previously—Lynne Jones and Andrew Miller. Would you care to make any kind of opening observation or would you wish just to introduce your colleagues and we will commence the questioning?

(Professor Stewart) Chairman, at the outset I would like to introduce my two colleagues. I have on my left David Wilkinson, who was Head of the Science Branch of the old Department of Education and Science, that is, before the Science Branch became part of the Office of Science and Technology. He is a historian by training. On my right is Robert Foster, who joined the Office of Science and Technology from the DTI, and he is an engineer by training. I am a biologist, a scientist, by training, so that between us we cover the arts, science and engineering. If I could say a few words at the beginning. First of all, I am pleased that earlier this year when I listened to the debate on science and technology in the House there was support, I think on all sides, for the setting-up of the Office of Science and Technology and for the appointment of a Cabinet Minister, Mr Waldegrave, as the Cabinet Minister responsible for science. Let me say, Chairman, that the Office of Science and Technology is still a fledgling organisation which is trying to establish its place and its position during difficult times in the Whitehall machinery with the scientists, technologists, engineers and in industry, so I am personally delighted that your Committee has been set up to monitor us and, indeed, I hope also to help the Office of Science and Technology. We need all the help and support we can get. During our period this morning, Chairman, I would like as best we are able, to share the way forward with you, to share the objectives that we have, the aims that we have, the aspirations that we have, and the concerns that we have. We have to set in place a forthcoming White Paper which will benefit scientists, which will benefit wealth-creation and aid not only the strong industries such as the pharmaceutical industries but also some of the industries which have been less successful. Having said that, Chairman, I hope you will appreciate that at this early stage and with the preparation of the White Paper in hand we may not be able to answer, as frankly as you might like, all the questions, and no doubt the challenges, you will pose. Nevertheless, we will try to do what we can. Thank you.

370. Thank you. I am sure it will not come as a surprise to you that we entirely share your view. This is an issue of exchanging views at this point, seeking jointly to influence for the betterment the new opportunities that you and your fledgling department have provided, but let me start on that issue. I think there has been a very general welcome for the creation of the new department but you and I and the Committee know very well that it depends on whether the structure can actually produce the policies and work effectively to these ends. We are a bit concerned, are we not, about perhaps the overwhelming nature of OPSS, the wide range of activities conducted therein and the position of the science element within it. Can you give us the assurance, even at this early date, that you think that the development of putting the OST into a department like that is an entirely welcome development? Do you feel sure that you will be able to create what you wish to create within that department without too much difficulty, and are you satisfied still that your rights of access to the Prime Minister are undiminished by this bureaucratic change?

(Professor Stewart) Chairman, I am convinced that the right decision was taken; secondly, I am convinced that we must do is set in place something which will serve the United Kingdom well, not only today but, importantly, in the future. The creation of the Office of Science and Technology within the Cabinet Office was an important and positive step. It is, of course, part of the Office of Public Service and Science headed by Richard Mottram, who is the Permanent Secretary and is the accounting officer and a very good Permanent Secretary. Within the Office of Public Service and Science there are various central sections. There is the Next Steps team, there is the Efficiency Unit, there is the Citizen's Charter Unit, the Machinery of Government Unit, etc., and the Office of Science and Technology is also there. The OPSS is a unique arrangement as far as science and technology is concerned at the present time. Nevertheless there are several points. First of all, the OST has just been set up; it is eight months old and it is not where it is today that is most important; it

[**Chairman** *Contd*]

is where it might go in the longer term. It is for you to comment upon and for government to decide upon. Second, the setting-up of the Office of Science and Technology in the Cabinet Office has been important. It has raised the profile of science and technology across Whitehall and it has been warmly welcomed by the science and technology community. It is located at the heart of government in the Cabinet Office; it has Mr Waldegrave fighting for us at the Cabinet table; it is headed by the Chief Scientific Adviser, who has access to the Prime Minister and his Cabinet colleagues; it has responsibility for ABRC and ACOST, for the Science Budget, etc. That is a start. We must try to build upon that. I am content that the Office of Science and Technology is where it is at the present time but we must build in the longer term for the future.

371. You are confident, then, having had a little experience now, that it is the right decision?

(Professor Stewart) It is the right decision to have the Office of Science and Technology close to the heart of government, close to the Prime Minister and within an organisational framework which we hope in the longer term will benefit the scientists at the bench and the industries that depend upon it.

372. So the role of science could well be enhanced by this, as it were, structure set, as you put it, in the heart of government?

(Professor Stewart) I would be very interested to see your response to that.

Sir Trevor Skeet

373. On the other hand, Professor Stewart, science is not something that is your sole responsibility. You have got many responsibilities outside it. How will you be able to control what is likely to be an autonomous DTI which has got quite an empire in science of its own? Will you not collide?

(Professor Stewart) It is not the job of the Office of Science and Technology to control the DTI. That is not our role. Basically I see the Office of Science and Technology, at present, as the gel in the middle which helps science and technology, by getting in place a structure which will serve us well. We are not trying to control anybody. we are working in cooperation and together with other departments towards common objectives.

374. But, Professor Stewart, are you saying that your writ will not extend to the DTI and if they want to challenge you on any particular subject we have got two Ministries of Science, in fact?

(Professor Stewart) No, the Office of Science and Technology is precisely that; it looks after science and it has a responsibility for technology. It's role is to overview the totality of government progress in the general area of science and technology. There are some areas like statutory, regulatory and other areas which are quite properly the responsibility of the Department of Trade and Industry.

375. If I can just pursue this s step further. You will have an interest in SERC and space. DTI may have an interest in space too because of their investment in the subscription. If you two did not see eye to eye, how would the matter be settled? Would you settle it or refer it up to the Cabinet Committee?

(Professor Stewart) It would be settled at the present time by the President of the Board of Trade because last year a decision was taken that space would become the responsibility of the Department of Trade and Industry.

376. Therefore we come to the position now that you have got two elements which are responsible for science: the Board of Trade on the one hand and your Department on the other. Is not science going to be ill-served if you are divided?

(Mr Wilkinson) May I just comment on the constitutional relationship here. The point is that it was very soon after the creation of the Office of Science and Technology that Mr Waldegrave on behalf of the Government announced that there would be a White Paper on science and technology and he sees the office of Professor Stewart driving forward a government-wide effort to define its aims and purposes for science and technology. After the Government has announced what it is seeking to achieve through its S&T policy then it will be possible to ensure that a government-wide commitment is, as it were, policed and overseen by that Office.

Chairman

377. Let us be clear about that, Mr Wilkinson. In due course of time there will be, as it were, a right of overview exercised in terms of approving the direction of science in the other departments over which——

(Mr Wilkinson) I think that is inviting me to jump my fences. What is now going on——

378. Not a bad invitation!

(Mr Wilkinson) My apologies, Chairman. Ministers are currently considering this as part of the exercise to produce a White Paper.

379. Right.

(Mr Wilkinson) What I am anticipating is that the question that you and Sir Trevor are asking will be addressed and the relationship between Departments will be central to the White Paper.

Sir Trevor Skeet

380. One final question on this. I wonder whether we have missed an opportunity not to pursue the German idea to have a ministry solely for science?

(Professor Stewart) I believe that at the start of the next century the UK Government will require a Ministry for Science.

Chairman: That is a reasonable answer to your question.

[**Sir Trevor Skeet** *Contd*]

Sir Trevor Skeet: Yes, certainly.

Mr Batiste

381. I am trying to fit together the answers that we have had so far this morning. The impression which I have got thus far is the role which you are undertaking in OST in relation to other departments is one where there will be a fair amount of influence and flowing of information but if there is actually a divergent view between you and the department of what can be done the key area is your relationship to the Prime Minister's Office and obviously the importance of being at the heart of government and in terms of the effectiveness of the effort towards the development of strategic policy amongst potentially disagreeing departments, being at the heart of government must be very important. Would you consider that having moved from the Cabinet Office to the present structure you are further from the heart of government or nearer to it?

(Professor Stewart) Let me take the first point. How does the operation work? First of all there is an official committee which takes aboard the Chief Scientists of all the departments or their nominees and that considers trans-departmental policy on science and technology and I chair that committee. That committee underpins the Cabinet Committee on Science and Technology which is chaired by the Prime Minister which takes a Cabinet-wide view of issues related to science and technology. So it is at that Cabinet Committee where science and technology policy is decided by government. We underpin that Committee. The decisions are taken there and then we, as best we can, together with our colleagues in other departments, go and implement what has been decided by that Cabinet Committee.

Dr Bray

382. There are two particular aspects of the work of the Scientific Adviser. One is to advise specifically on scientific issues which are high profile and advice has to be given directly to the Cabinet. The other is on the broad level and direction and distribution of scientific resources. Presumably the first category—to give an example, supposing there were fears over the Cabinet advice on whether BSE could cross species boundaries and there was some question mark over the independence of the advice they were receiving and the independent advice would be direct to the Cabinet, clearly cross-departmental. You would regard it as your function to give that advice directly to the Prime Minister overruling all other considerations?

(Professor Stewart) It is a judgment about whose responsibility it is. It is my responsibility to take anything across the totality of government which impacts on S&T where I think the government is not getting the best possible advice and if it is necessary for us in the centre to intervene a) we would do that . The second thing that we would do is that if we ourselves see areas which we think are particularly important for the government to have a policy or to take a stance on, then we would initiate these in the Office of Science and Technology and take these forward.

Dr Bray: Yes but I mean let us be quite specific. There is evidence, let us say, that children of employees at Sellafield are affected by the radiation to which their father was exposed before the time of conception. The evidence is dodgy. It is dismissed by the Department of Energy. You think that maybe the evidence ought to be looked at more closely. You have good reason to believe that. You would consider it open to you to go direct to the Prime Minister and say, "This has to be examined." "This is my best estimate of the evidence at present and these are ways of pursuing it."

Chairman: I think we have to be careful of making statements which might in some way relate to a case which I understand is under examination but the answer I am sure you be able to give will prevent that.

Dr Bray

383. It is not in any way *sub judice*. It is a current issue that we are concerned with here.

(Professor Stewart) Chairman, thank you for that helpful comment. The position is that on an issue which involves other departments as well as the Office of Science and Technology, I would normally speak either to the Chief Scientific Adviser in that department or I would speak to the Chief Medical Officer if that was the appropriate Department. We would have discussions and at the end of the day if I felt it was necessary for me to give advice to anyone within the totality of government, I would so do.

384. This is an important point because that is a qualified answer and it is a current case. Let me take a historical one. In the Sixties the Ministry of Aviation was arguing that supersonic flights over land were perfectly acceptable and they did experiments over arbitrary towns, day and night-showing and if there were bangs the babies were bonnier and the cabbages grew larger and all the rest of it. This was plainly non-sensical evidence which was related directly to the Cabinet when a supersonic flight was laid on over Whitehall during a Cabinet meeting so they could hear the bang. Is that the kind of intervention that you would regard as necessary in the event of a plain departmental fight.

(Professor Stewart) If there are departmental fights and if advice is needed on what is the best way forward and we have an Office of Science and Technology which has a trans-departmental remit, it would be right and proper for the Chief Scientific Adviser and the Office of Science and Technology to give that advice. The Chief Scientific Adviser has to stand back, make his own judgment as a scientist or on strong S&T advice. He must make a judgment as to what he thinks best and if the judgment implies giving advice to somebody within the Cabinet, then it would be done.

[**Dr Bray** *Contd*]

385. The other function is advice on the broad direction and distribution and level of scientific resources. Now there do you distinguish between money on the one hand and science on the other or is money inextricably linked with science? In other words is there a distinction between your role and that of the Permanent Secretary?

(Professor Stewart) There is a distinction in the sense that I am not the Accounting Officer for the money. My role as the Scientific Adviser is to make a judgement on the quality of science that has been bid for and on the basis of bids that are made I would to advise the Treasury and indeed the Cabinet on expenditure between different factors related to science and technology.

Chairman

386. Could we ask a further question on that now that Dr Bray has raised this. We know that you are not the Accounting Officer but are we right to assume you participated in all the discussions between Treasury and OST dealing with the science budget in the recent PES round?

(Professor Stewart) In relation to the budget and the last PES round, the position that we follow is that the Chief Scientific Adviser has the opportunity to discuss with departments their particular case bids related to science and technology. Having done that the CSA is in a position to advise Treasury of his views if he so wishes. The Treasury in its discussion with departments or through EDX will no doubt wish to take account of these or not, but I do not attend the meetings where that occurs.

Mrs Campbell

387. We are very interested in this role, Professor Stewart. Did the recent discussion create tension between departmental scientific advisers and yourself? Was there any conflict, in fact, between the advice given by them and the advice given by you?

(Professor Stewart) There are always discussions between officials. Let me simply say that I work very well with officials of other government departments such as the DTI. I have a very close working relationship with the Chief Scientists. By and large we think very much alike on many issues and I am confident that there is no conflict.

388. But there is a difference of views from time to time? I think it would be surprising if there was not a difference of views.

(Professor Stewart) You have answered that for me!

389. Despite your good working relationship, if there is a difference of view at the end of the day, whose advice is the Treasury taking? Is it departmental views or your advice?

(Professor Stewart) I do not think there is a difference of view as far as the Treasury is concerned. Clearly the CSA in the DTI will input views to the Treasury via the President on DTI issues. The difference between his role and my role is that I have been given responsibility by the Prime Minister to look at science and technology across all the departments and try and make an independent input to the thinking.

390. So the science and technology issues within the Department you may be giving different advice from the advisers in the DTI about the expenditure on particular projects, for example.

(Professor Stewart) The judgment that I would make of a particular departmental input would be taken against the backcloth of all the departmental inputs and as such it may well be different from what the advisers in one specific department might make.

391. How is that resolved? Does the Treasury decide whose advice it is going to take or do you sort it out between yourselves?

(Professor Stewart) By Cabinet and EDX at the end of the day.

Dr Bray

392. In the preparation of this year's public expenditure round did the Chancellor of the Duchy systematically visit the major research establishments of Departments like Transport, Environment and Trade and Industry?

(Professor Stewart) There are something like 200 establishments.

393. I said the major ones. Did he visit the National Physical Laboratory, the Building Research Laboratory or the Transport Road Research Laboratory?

(Professor Stewart) I am quite sure the Chancellor of the Duchy of Lancaster did not have time to visit every major establishment in the short time he has been in office.

394. Which ones did he visit?

(Professor Stewart) I do not know offhand.

395. But he did not systematically look at the main research effort in every department?

(Professor Stewart) I have certainly visited and talked to many of the key spending players across the Whitehall scene. I too must admit that I have not been to each of the 200 or so laboratories but we work very closely with departments and very recently, for example, I had a meeting with the chief executives of each of the agencies which have an S&T base and we considered collectively various issues which impact on a variety of issues, including funding etc.

396. Can you let us know which specific visits were made to which establishments?

(Professor Stewart) Can I send you a list of these.

Mr Powell: By both the Ministers.

Chairman: Can we turn to staffing now within the OST. Mr Batiste?

Mr Batiste: As a keen watcher of "Yes, Minister" I have always been amazed that one of the

[**Dr Bray** *Contd*]

primary ways you detect the success or failure of a department is by staffing levels and whether they are rising or falling. Given the higher profile of science and technology and your coordinating role, would you expect post-publication of the White Paper that your staffing levels will rise or fall?

Chairman

397. You may get one of your colleagues to answer that if you wish.

(Professor Stewart) Let me put it this way. Our workload has increased enormously since the Office of Science and Technology was set up and I can honestly say that I have never worked harder since I was a young post-doc. when you take aboard the fact that we have had to bring together the DES Science Branch, the S&T Secretariat, the fact that we have to find ourselves new accommodation, the fact that we have a White Paper, the fact that we have an Allocation Management and Use of resources study, the fact that we have two ministers to serve, our work has increased enormously and I hope that will be reflected in some positive way in the White Paper.

398. So your present staffing levels are a constraint on the work you can do?

(Professor Stewart) The present staffing levels are what they were before the Office was set up and we are working flat out. Let me say I have an exceptionally good staff.

Lynne Jones

399. It tells us in these briefing notes that you have five additional staff who have been brought in to look at the allocation of resources to science and technology. Could you explain where they have come from and where they are going to when they have finished?

(Professor Stewart) Can I make a preliminary comment and then I will answer your question. I am a firm believer that the way forward for the Office of Science and Technology is to bring in experts from outside for short periods who are skilled in science and technology and associated issues, that we should use these effectively for a short time and then they should go back out again. That, I believe, will benefit the Office of Science and Technology, it will benefit them and it will benefit where they came from. So I am a firm believer in "inning and outing" I do not believe that large generic organisations will have in-house, or on any one committee, all the expertise they need for the future. Having said that, on the question of where do the staff come from, the official who is leading them came in from DTI, we have an independent consultant from the private sector —-

(Mr Foster) There is an HEOD who has come from Customs and Excise.

(Mr Wilkinson) Perhaps the point to make is that the people we have brought in, it is for a fixed short term and then it ends and they return, but amongst the group there is one colleague from the OST, Dr Dowdell, and there is also a trainee grade, Mr De Souza, and, as Professor Stewart said, there is Mr Green from DTI heading it up, who is an economist, and the chap from the consultancy firm, Mr Kemp, is a physicist.

400. But the point I am really trying to make is, they have a very important remit in terms of allocation of resources. Will they be responsible if they get it wrong? People come in and make recommendations of fundamental important and then go away again. What responsibilities have they?

(Mr Wilkinson) They have been set the task. The terms of reference are to advise ministers on the allocation of resources. That is fed in through Professor Stewart, who chairs an advisory group across the Whitehall group of spending departments for science and technology, and it will be for Professor Stewart and that group and then the Office of Science and Technology to reflect its interpretation of the findings in the White Paper. So any mistakes, as it were, will be ours. We must evaluate the evidence, as we do in all other exercises.

Cheryl Gillan

401. Professor Stewart, we have heard recently in some of the evidence we have taken about problems of communication perhaps between the science side and the industrial side, and the President of the Board of Trade recently announced he is going to increase the number of secondees into his department from industry up to the level of 100. I understand he is well on the way to reaching that total. In light of the general view that there are communication problems, are you considering having secondees into the department from industry in the near future, and if so, to what level?

(Professor Stewart) Yes, we are. We want to have more inning and outing, as I have said. We intend to get people from industry; indeed, we have secondees from industry with us at the present time. It is important to bring in excellence underpinning our remit wherever they come from and industry, is an important area.

Chairman: Can we turn now to the Science Budget. Mr Williams?

Mr Williams

402. Can I ask about the settlement that was reached last week, or announced last week, in the Autumn Statement. It was a very tough public expenditure round and I have read the press release from the Office of Public Service and Science and it is modestly up-beat in tone. When you look carefully at the figures, really the settlement for next year is an increase of 4 per cent. in cash terms, which is a very tiny increase in real terms and really stagnation then for 1993/94 and 1994/95, so in fact a cut on previously announced provisional figures for the following two financial years. Is that a reasonable interpretation? Is it a fairly stagnant budget?

(Professor Stewart) Let me reiterate—I thought somebody would ask me about public expenditure

[**Mr Williams** *Contd*]

—it has been an exceptionally difficult public expenditure round, as we all know. I said when I spoke at the Foundation for Science and Technology in June that OST could not have been set up at a worse time, that money was likely to be short, and I think so it has proved to be. The position is that government expenditure on civil science and technology will grow, I think, by 1 per cent. over the survey period, with total expenditure rising from just under 3.4 billion in 1992/93 to 3.7 billion in 1995/96. These are provisional figures. The science base will show cumulative real growth over the survey period of some 2.8 per cent., and within this the Science Budget has been protected and will rise in real terms by about 1.4 per cent. between 1992/93 and 1995/96. That is excluding any money transferred from the higher education sector. As the Government's Chief Scientific Adviser I wish we could have done better but when I see the backcloth against which we were operating, as a man in the street and as a taxpayer in a country that is fighting a worldwide recession, I have to be a realist. I would go on to say that the Office of Science and Technology, I hope, has not been set up as a temporary whim. We are at the beginning of a new process of strengthening science and technology and we have to take a longer-term perspective. We have to build steadily for the future and external circumstances depend on how well we do in particular years. I suspect, Chairman, that I am slightly different from politicians, if I may say so, who have to think sometimes in the shorter term —

Chairman

403. All the more welcome for that!

(Professor Stewart) — whereas we have to try for science and technology to decide where we are going, try to batten down the hatches when it is important to do so but make sure the ship keeps moving forward.

404. Let us press you on that point. What impact do you anticipate these figures will have on the main programmes of your research councils?

(Professor Stewart) That is something we would want to work on with the research councils.

(Mr Wilkinson) Chairman, as you will have seen from the press notice that Mr Williams has referred to, we have there the letter which Mr Waldegrave has sent to Sir David Phillips, the Chairman of the ABRC, and there we are inviting the ABRC to consider the implications of the new settlement on the programmes in consultation with Professor Stewart and his colleagues. I think that if one looks at the figures and at the modest first year increase of 1% in real terms, it is important to remember that over a planning period the ABRC has pursued a policy of retaining a contingency fund of 1% and 2% and 2%. So there is already within the overall budget a small contingency then of £11 million and then £25 million and then £26 million. But it will obviously now be for the ABRC with the research councils to consider beyond the margin to ensure that within the funds available they now get the best out of the budget, in scientific terms, that they can. The process is that it will meet on the 25th November. Subsequent to that it will offer the Chancellor of the Duchy advice on the best way of getting value for money from the new level of the science budget.

Mr Williams

405. When the research councils have to operate under such a very tight budget and when the squeeze is on permanently where does that squeeze particularly affect—is it PhD students or post-graduate work? Is it the case that the long-term capital projects continue but that may be at the expense of young graduates?

(Professor Stewart) I ran a research council for three years so I know the sort of problems that any shortage of funding can have. Basically one of the problems is that a lot of the research is long-term and you make a long-term commitment to it and there is very limited flexibility in what one can do. What I tended to do at AFRC was to cut short-term projects. The important thing—and the answer to your question—is that each of the research councils has its priorities and different needs at particular times and it is best to go to them and they will have to take a decision of how they best address the problem. But you have got to get back to the fact that in real terms the figure is increasing. The point is that it is not increasing as fast as some people would like.

Dr Bray

406. Nevertheless the position is what is it about science that should have meant that while the total Government expenditure exactly achieved the planning total previously set forward, the science budget had to be cut on the previously planned budget?

(Professor Stewart) I think that is something you will have to ask a Cabinet minister.

407. And why is there no evidence in any of the departmental press releases of any influence upon their research and development expenditure?

(Professor Stewart) I think again that is something you will have to ask departments.

408. Is it not rather a disappointing start for a new office that not only is there a total cut on the previously planned levels but there is no sign of the rest of government having in any way noticed the existence of the new office?

(Professor Stewart) You might want to reflect on that as a Committee.

Chairman: That is a fair comment to make.

Mr Williams

409. Could I come in with a related supplementary. One of my concerns, if you look at the defence budget there is a substantial cut of £1 billion from

[**Mr Williams** *Contd*]

the defence budget. Presumably the research side will be cut along side that. If you look at the changes in the Health Service they do significantly threaten research work in hospitals that have become trusts. There is a danger here of defence research being cut and of NHS research work being cut and really our total science R&D actually falling.

(Mr Wilkinson) I am not absolutely certain that I followed Dr Bray's comparison. I wonder if I could invite him, through the Chairman, to explain. You are saying that the outcome over all of public expenditure was level funding?

Dr Bray

410. I am saying that the planning total as set out in last year's Autumn Statement for the coming year is exactly the same. It is £244.5 billion as the planning total adopted for next year in last week's statement.

(Mr Wilkinson) The point in that case that I should make is that, within the global aggregate there has obviously been a redistribution and the point at issue therefore is that indeed, as Dr Bray says, there has been a small reduction in the planning total for the science budget over the three year period. Nonetheless the Chancellor of the Duchy has maintained a 1% increase over the period which is lower than the planned increase but nonetheless as an outcome of this particularly difficult expenditure round that is the outcome for the science budget.

Cheryl Gillan

411. Surely that is quite prudent because we have set up a new Department and presumably there are some savings to be made somewhere by the formation of a new Department. And if the level of spending in this area is going to remain that same does that really indicate that the Government is broadly satisfied with the overall spending?

(Professor Stewart) Can I come in. Let me say that I do not think that spending on science and technology, overall, relates at all to the organisational structure that there is at the top of OST. I think that money for science and technology should relate directly to the scientists and technologists at the bench who are able to use those funds. The question about savings because of the new organisation has got nothing at all to do with the overall needs of the people who are actually working at the bench.

Mr Batiste

412. If I put it the other way round and say until you produce a White Paper and one is clear on what strategy it is that you are pursuing it is very difficult to see how in the context of a very difficult PES round negotiation you are able to negotiate significant increases. Is that a fair comment?

(Professor Stewart) I think that is an extremely fair comment.

Chairman: Could we then turn to the question of priorities, what you are going to do. Mr Powell?

Mr Powell

413. You are very aware that we have received quite a lot of evidence to suggest that there is no effective measure of innovative capacity or achievement of the results of research and development, that statistics and other evidence as to the importance of a company's ability to survive and grow are difficult to obtain and certainly illusive. Is it any part of your Department's priority to change this? If it is, what are you doing and what kind of priority are you giving to that work?

(Professor Stewart) There are several issues. First of all it is quite difficult to measure the relationship between input and output measures but people such as Mansfield have shown positive correlations. Secondly the Japanese, for example, even when they are going through a difficult period are sustaining their investment in R&D. Thirdly, I do accept with you that output measures are terribly important in relation to what one hopes to achieve and one of the roles I think the Office of Science and Technology will have in the future is to try to make sure that the money that we have available is used as effectively as possible and that we have output measures against which we can gauge what has been delivered. Let me add a word of caution, however, as a scientist. It is quite difficult to get output measures in some sectors because science and technology is a long-term business You do not always know what is round the corner and it does take a considerable period of time. But we have to work towards making sure that the money is used as effectively as possible. We have to make sure that the most able people and the most able projects, whether these be related to the science base or whether they be related to wealth creation, are properly funded.

414. Notwithstanding the fact that the evidence at the moment is, as I have said, elusive there are those who would say that the application of proper research and development, that evidence will become a great deal firmer and clearer than is currently the case. Is it not therefore clear from the answer that you have given that at the moment the priority of the Department is that you are doing nothing about this and you do not give it a very high priority?

(Professor Stewart) Not so.

415. What are you doing about it then?

(Professor Stewart) What I am saying is that that is a continuing process. We appreciate that is important. We are working towards it. David, do you want to come in on that?

(Mr Wilkinson) Yes, Chairman. Mr Powell no doubt knows that a good deal of initiatives have been taken in this area by the DTI and by the different research councils. As Professor Stewart has said, one of our difficulties is that the relationship is elusive. It is a feed back loop rather than a straight line from science through to technology into new products and processes and economic success. The key thing that we are doing about it, if you count as "we" the scientific system, is that we are producing

[Mr Powell *Contd***]**

good people. We are producing young doctorates who are at the leading edge. We are producing people who are tying into networks internationally on what is going on and what is about to break and they are going out many of them—because not all of them stay within the academic or research system—and I think that the key output in these terms from our investment in the science base is in terms of people. Now one of the things that we and the research councils have found is the difficulty of encouraging this flow and various schemes have been introduced to build this up such as the Teaching Company Scheme run by the Department of Trade and Industry and the SERC; the Cooperative Awards in Science and Engineering where the grant is topped up by the firm; the Integrated Graduate Development Scheme in which the research students come in and do a specific project of research for the firm. So this is an area where a good deal is going on and I could not agree more with Mr Powell that this is something where we do need to succeed and we are encouraging these things and I do believe it is going to be one of the highest priorities and it is a matter on which colleagues of mine are working very closely with colleagues in the DTI.

Mrs Campbell

416. Perhaps I can ask my question first; I know Professor Stewart wants to move in again. What Mr Wilkinson has just described is really the sort of process that you are going through and I think what we are interested in there really is the sort of performance indicators you have looked at. I do not know whether these are measured entirely in terms of people or in terms of output. Have you had any preliminary thoughts about the other sorts of performance indicators you might be using to measure your own performance and to measure the performance of research councils and if so would you like to share those with us?

(Mr Wilkinson) Performance indicators for the Office of Science and Technology I think in many ways we are going to have to be judged on the basis of the White Paper and our ability with ministers to come forward with a coherent set of policies which give direction and thrust to what we are doing in the field of science and technology. The point is that we do not, and are not in a position to have the expertise to take upon ourselves the delivery of all of this. It is going to be delegated down and we will be inviting the research councils and other players, the universities, the government-run laboratories themselves, to define their missions and make statements of what their output should be and then to demonstrate that they have brought forward those outputs in a cost-effective way. So it will be a delegated process down to the bench, as Professor Stewart said.

417. Can I just come back to what Mr Powell is getting at too about innovation for the manufacturing industry as well in terms of how the science applied at that level actually has some spin-off. Do you not regard it as your job within the OST to collect statistical information which will enable your office to give advice about the way in which science and technology can benefit the productive capacity of firms. What sort of performance indicators and what sort of statistics, if you like, are you collecting or thinking of collecting in order to give better advice to firms?

(Professor Stewart) Can I try and make several points. First of all the UK needs a strong wealth-creating base. I think that is something we would want to try and achieve. We at the Office of Science and Technology must help to provide that. There are two things that we are concerned about. We are concerned about, as David Wilkinson said, the people base. We must make sure we have the skills level. We must make sure that we have them in the areas that we need them and it is possible—and we are working on getting the factual information on that, on what the projections are—so the people side of the science base is one. The second thing, as I said, is we must try and ensure that we have a successful industrial wealth-creating base in this country. It is important that we try and see areas where the UK might be more competitive in the future and at present Graham Walshe, sitting behind me there, is looking at research foresight; about where we need to go in the future. We are interested in output measures like patents. We have produced a report on intellectual property rights because we think that is important. We decided that we would set up a programme on generic technologies because the generic technology base of the UK is not as strong as it should be. We took a positive decision that not only would we do that for the UK, but we would try and impact that on to the European Community generally. On generic technologies we would take the lead in helping shape the way forward. These are the sorts of things we are trying to do.

418. I can see what you are trying to do but I think there is an emphasis on what you are trying to do. There also has to be an emphasis on what you measure and how you measure your performance at the end of the day. I think that is what we are getting at now and trying to focus your minds in thinking in that direction.

(Professor Stewart) I think it is a very important point that the people and skills base and all the issues related to that are important and the other one, of course, relates to the measures that we can take to ensure the S&T is used towards wealth creation.

Sir Trevor Skeet

419. Professor, you mentioned the Japanese a moment ago, 26 per cent of their research and development is done by companies in Japan and they settle their own priorities for only 80 per cent of the cost. Why do you think in the UK that you can settle the priorities in R&D and can the government do very much better than the companies have themselves?

[**Sir Trevor Skeet** *Contd*]

(Professor Stewart) I do not think we can do that. I think perhaps, that we have spent too long in this country with the cart before the horse. The role of the UK public purse and the taxpayers' money to make sure, as I said before, that we have a strong and prosperous economy. The people who know what they need are the industries and what we as officials must be doing is to try to deliver industry what it needs.

Lynne Jones

420. We have been talking about performance indicators and trying to guess what is going to happen in the future. What have we learnt from what has happened in the past in this? You have mentioned what has happened in Japan and perhaps there are ways in which businesses take decisions in a different way in other countries than they do in this country. So that is one issue that perhaps can be looked at and in terms of assessing the balance of future spending whether there should be a market pull directing the research or whether it should be purely a science push going in for pure research and seeing what that throws up for the future. How are we using the past the help us to look forward to the future?

(Professor Stewart) We have to be sure that we are not bogged down by the past. If one looks at Japan, it is very interesting. Sir Trevor gave us some data on investment by Japanese companies in-house vis-a-vis what they did in the public sector. If one looks at what is happening, looking forward not back, the pace of technological change, I believe, is such that no company in the world will ever be able to do in-house all the science and technology that it needs to do. It will have to contract out to the areas of expertise. If you look at Japanese forward plans you will see that they are appreciating that perhaps what has served them well in the past is not going to be optimum for the future and they too are contracting out. That is why this country needs a strong, publicly-funded research base to which industries can come and contract out their research needs.

Sir Trevor Skeet: Are you going to be analogous to MITI?

Chairman

421. That is a fairly significant question.

(Mr Foster) Can I handle that. I think one has to be very careful in talking about MITI. It is very emotive in terms of intervention and so forth. I think there are some areas that MITI do to which Professor Stewart was referring, particularly in areas like trying to look at what are going to be national needs in the future in terms of technologies, which is a very legitimate role for the Office of Science and Technology to be doing, particularly in this area of foresight both nationally and in Europe. Just to give an example of that, if I may, with a little more detail on what has already been alluded to. I chaired a meeting across Whitehall to agree there should be a pilot study to look at whether you could define the criteria for what are going to be important technologies in the future and to identify what types of research programmes one should be doing now in order to develop these key technologies. Similarly in Europe following OST's lead, there is now agreement by other countries that this type of exercise is worthwhile. MITI is seen to be highly interventionist in terms of large subsidies to industry and so forth. That is not the role of OST. OST is doing a much more limited job, for example to get industrial objectives hopefully projected more into where the research spending in the future.

(Professor Stewart) Can I come in and amplify that. What I said to Sir Trevor is exactly what I believe. That is, that industry should be deciding what research and development, by and large, needs to be done. On the question of the role of the Office of Science and Technology and whether it is tied up specifically on the science base, let me say that we have been going out and working closely with industry, gauging what they need and what their views are. For example, on Friday I will go to Rolls-Royce, Robert Foster was at Hewlett Packard last Friday, we were at British Aerospace the week before. The Chancellor was there. I met with the research directors of Wellcome, ICI and Glaxo last Friday, I met with Bob Malpas on Tuesday night, we have a meeting with the President of the Board of Trade tomorrow. I say that simply to alert you to the fact that we too are interested in industry, we are interested in wealth-creation and we want to work with the Department of Transport, the Department of Trade and Industry and others in this area. We have to appreciate that industry is not solely associated, in science and technology, with one Department. There is the Ministry of Agriculture, the food industry, the health care industry. There is a wide spectrum and we have to work closely with industry in all of these areas.

Mr Batiste

422. Whilst we are looking at these international comparators and links, one of the very interesting questions that came out of our session with the industry group was the extent to which, so far as their companies are concerned, science is international and they will fish in other countries' science and technology bases for their particular products. That actually poses some very serious strategic problems for the United Kingdom in the sense of the extent to which we must regard our science and technology base in Britain as essential and exclusive of what goes on overseas and the extent to which we should try to see it as a way of providing gaps for our own domestic industries and what they, for one reason or another, cannot get overseas. How do you see that? I must say my initial reaction to that, perhaps our initial reaction in starting, was that the domestic science and technology base is particularly important in relation to people and training of our people, but those answers from the industrial group

[**Mr Batiste** *Contd*]

tended to suggest that in relation to the actual knowledge being produced by that science and technology base it was less important.

(Professor Stewart) I agree entirely with you that science and technology is a global issue and I always try to remind ourselves of two things when I sit round committees such as this and elsewhere. There are two things that we must remember as we go down the road. One is, as I said before, that the people who are important are not the people sitting round this room; rather they are the people who are actually doing the science at the cutting edge. The second thing we have to remember is that we are a small nation in a big pond with 95 per cent. of the R&D being carried on outside the United Kingdom. The question is, how do we compete effectively? I think we compete effectively by making sure that we are an attractive country for companies with a high S&T base to become involved in and to develop for the future. I think that we are actually fairly successful in this when one takes areas like the large pharmaceutical companies. They come here and they stay here simply because of the cutting edge skills we have and the infrastructure which industrialists and the academic R&D base have and how they interact. So that to me is the most important thing. Looking out there to the world, I am sure that British companies will have to make use, and do make use, of the best R&D base wherever it is anywhere in the world, but we must get more than our pro-rata share, which will deliver more wealth-creating industries to our country. I think it is possible for us to do that by having a strong infrastructure in S&T.

Mr Powell

423. There are those who say, particularly from industry, that there is too much science and not enough technology in the science and technology area, and although we are delighted to hear that you and ministers are visiting commercial enterprises, I assume that there is absolutely nothing new about that and that Sir Giles Shaw and Dr Bray did it, when they were Labour ministers, before some of us were born! The real question is, is the department giving a higher priority to the input from industrialists in selecting the areas in which the budget is being spent, and if it is, can you tell us how it is, please?

(Professor Stewart) These are the issues we have to address in the White Paper to some extent, but there is no doubt about it that the Office of Science and Technology is working closely with industry in various ways. I regularly bring in groups of industrialists to sound them out on what is needed. As I said, we are working with industry and others on the generic technologies, we are working in close collaboration with the pharmaceutical industries, and we are working towards how we can best ensure that we have, in the United Kingdom, the R&D base which benefits them. If I may say so, the distinction between science, technology and industry is not clearcut. If one takes genetic engineering, the process of stitching and snipping and resplicing genes, etc., it was in the early 1970's that such discoveries were made. It is likely to be the technology which in the future will underpin the health care industries of this country. As the pace of science and technology increases, the time-frame from science and technology to product will shorten. We have to try to couple the science coming up from the bottom to the technologies which industry needs coming down from the top.

(Mr Wilkinson) Could I just try and place in context perhaps Mr Powell's question? One tends from the inside to over-value what it is that one is directly responsible for, so I tend to look at the science budget as the important thing. I was reminded by an industrialist on SERC at the last council meeting that their engineering budget per year is 1 per cent of what the companies in this country spend on their R&D, so the gearing is very, very important. I think this comes back to Mr Batiste's point as well, namely that naturally enough if you are within your own country just one-hundredth of the output then it is not so much the knowledge that you are looking for, it is the people, the skills, the contacts, the know-how and the awareness of what may be happening in the immediate and longer-term future which is the key output. Obviously we all discuss with industrialists how best to get the best rate of return from the public investments in this, but I remember a session at the Royal Society in which an industrialist began with three slides all addressing the question, "What do we want from the science base" and slide number one was people, slide number two was people and slide number three was more people, and this does seem to be what industry is asking us for.

Chairman

424. That allows me, I think, Professor, to ask a fairly firm question. You chair the committee of scientific advisers, is it not desirable, bearing in mind what we have just been discussing, namely Government's role in science and Government's priorities, that that group under your chairmanship with the "over-view" in your pocket should not actually have some formal responsibility for setting priorities on Government spending on research?

(Professor Stewart) That is something which the White Paper will want to debate.

425. So that might be an issue you would actually have in the White Paper?

(Professor Stewart) You are asking who disburses the money for research?

426. It is not that, it is a question of whether there should be some formal link between your Office, not only as Chief Scientific Adviser to the Prime Minister, but your Office, the OST, with your colleagues in other departments, bearing in mind the importance of honing the Government's scientific effort, taking the limitations, as Mr Wilkinson has said, of the absolute amount in respect of resources

[**Chairman** *Contd*]

for research. Is it not right that group should not have within its responsibilities the decision to set priorities on what the Government's spending on research is all about and where it is directed?

(Professor Stewart) I would be interested in the comments which your Committee will want to make on this. It seems to me, at the end of the day, clear and important that science and technology based decisions are taken for the spending on science and technology, and the question is where, based within the totality of the Government's machinery, that should be taken.

427. But we have just set up this new office with its "over-view role" in shifting the science profile to the centre of Government, and you and your fellow chief scientific advisers represent, I assume, the technical core, the scientific core, of decision-making when it comes to deciding where scientific effort should really be made within Government.

(Professor Stewart) I cannot answer that question but I find what you say very interesting. You might want to respond.

Chairman: Technical merit low, but artistic impression reasonably high! Can we turn now to near market research.

Mrs Campbell

428. We have had some criticisms particularly from the Engineering Employers' Federation about the way in which the Government funds those R&D programmes which are near to the market place as opposed to other pre-competitive research. I wonder if you would like to comment on that and perhaps I will come back with a further question?

(Professor Stewart) There has been some controversy about what the term "near market" actually means. I am not sure that was not yesterday's model rather than today's model. I believe that the important thing about public purse funding is that it should be funding good research which under-pins basic research, strategic research or applied research, if it is worth doing, if it is necessary and if it is top quality work. I personally believe if you need good people in basic science, equally you need good people to under-pin very applied science. That is an area we have to look at very carefully indeed. I do accept that the term "near-market" is causing a lot of concern at present and has in the past. We have to make sure it does not cause concern in the future.

429. Are you then signalling a change of Government policy?

(Professor Stewart) The Government will decide what its policy is.

Mrs Campbell: I think what you are saying is that your advice will be perhaps the Government should not be quite as restrictive as it has been in the past two or three years in the way it has been less enthusiastic about funding near market research than some other areas?

Chairman: I think that was an eloquent raise of the eyebrows!

Mrs Campbell: Difficult to minute.

Chairman: Can we move on to the aspect of technology transfer?

Mr Batiste

430. In evidence to us from the research councils Professor Newby said, and I quote from him, taking a few words out, "... anything which puts barriers between basic and applied research attempting to convert our scientific excellence into economic successes is a mistake", and he talks in terms of basically applied research as being strongly interactive and that we need a two way flow of technology people and cash—a two way flow not a one way flow—which ties in very much with what you have already said. The problem is our perceptions, and all the problems we have had about indicators, and most perceptions people have about the success of technology transfer in Britain is that though it has improved considerably in the last decade it is still behind many of our leading industrial competitors. Where would you see at the moment the particular obstacles in Britain to a successful improvement of technology transfer, and what do you believe the role of your Department should be in overcoming that?

(Professor Stewart) Technology transfer is an important issue. I agree with Howard Newby there should not be barriers and I agree it is a two way transfer. I also agree that people are a very important way of ensuring technology transfer. We are back to the discussion I had with Sir Trevor earlier, and that is that we have to decide what particular groups need. We get back to the industrial dimension. I do not think there is any sense in setting up lots of schemes, for example, if those to whom you are trying to transfer technology (a) do not think they are particularly good schemes and (b) do not see that they are providing the service that they particularly want. I believe that the Office of Science and Technology has to look carefully at this question of technology transfer and that we have to work very much closer, I believe, in the future with the DTI Innovation Unit and others in trying to take the issue forward.

431. Do you see the intellectual property regime as any particular problem at the present stage?

(Professor Stewart) I have pretty firm views about intellectual property. I believe that intellectual property is best decided by those who are involved with intellectual property getting together and deciding between them before they go down the road very far how the intellectual property is going to be best handled. I do not think you should have a diktat from the top saying it will go one way or the other. It is very much to do with those who are at the hard edge, whether it is the people putting money in or whether it is the scientists who are delivering the science and technology.

Chairman

432. Is that something which will be pursued at a European level?

(Professor Stewart) We have just produced an OST paper on intellectual property because we too identified that it was an important area. It is something we have to work with the Europeans on, it is something we have to work with the Americans on, and something we have to work globally on. It is a terribly important area.

Mr Batiste

433. One further point: there was an extremely interesting speech made the other day that was fairly widely circulated from the Institute of Directors, from General Morgan, in which he said—and I think the indication covers a lot of different fields: "Where you have within a country highly competitive industries as a pool of highly competitive industries, you get the best technology transfer, the best research efforts," and he obviously, in relation to the United Kingdom, referred to the pharmaceuticals where that applies. Would you see actually the promotion of competition between technology companies within the country as being one of the best vehicles for promoting technology transfer from the public sector into industry?

(Professor Stewart) Yes, in general, but I think there is an area of pre-competitive research which takes aboard some of these areas such as generic technologies. That is where the Japanese do rather better than us, that they get together at the pre-competitive levels. They make sure that the infrastructure is there and as soon as it becomes competitive, bang, they are away.

Sir Trevor Skeet

434. Now that a new ministry has been brought into being, would you not agree, Professor, that the time has now come to tidy up some of the structures? There is the ABRC, which allocates the funds, and there is ACOST, which brings out a number of very learned reports; I think about 14 in number have come out. As industry has to declare its views, could not these be done by the Royal Society and one or two of the other enabling institutions?

(Professor Stewart) The question of advisory structures is important and you are right that we have ABRC, we have ACOST, we now have the Office of Science and Technology and we have these independent and important organisations such as the Royal Society. I would not want to say here whether ABRC, if you like, should be sustained, whether ACOST should be sustained, but let me make several points. One is that some of you may have seen reports of a recent meeting held at Gleneagles last week on industrial strategy and Tom Peters, who is a US management "guru"—he wrote "In Search of Excellence"—was a guest speaker and made the following points in his speech: the most significant thing we need in a company these days is a supply of erasers, rubbers; there are too many organisations; too many of them are too large and too cumbersome to survive the 1990s; there is no stupider statement than "close to the public" in a nine-layer organisation. It is not for me to say whether ABRC and ACOST or anybody else should have their roles taken over by the Office of Science and Technology, but I do not think that in this country, looking to the 1990s, we need duplication. I do not think we need large committees which are generic in function and do not have a particularly important role to play for the future. I came across a report from the Royal Society. I think they have sent you a copy of their evidence and we have reports from many different inputs and I just picked this one up because I thought it was important. The Royal Society's comment was: "It is not clear that a body such as the ABRC will be needed under the new arrangements since research councils and other recipients of the Science Budget money can bid directly to OST." Advice can come from various sectors and it will be important to decide how many advisory structures you do need. My own view is again that the best advice you get is when you bring in small groups of people who are at the cutting edge, get them to deliver on a specific project, and having delivered on that, you then disband the group and you bring in another group when it is needed.

435. If I can pursue this further, there are two reports by ACOST. One is on opto-electronics, in which the Japanese seem to be ahead. Could that not be referred to an ad-hoc committee of the Royal Society to deal with? Another one is on the industrial aspect of Sizewell B. Could that not go to the Royal Academy of Engineering, an ad-hoc committee, to decide that, and then you have dispensed with a major committee and put it on to another one which is very learned and very broadspread?

(Professor Stewart) These are very interesting suggestions. I would say the Royal Society has some of the most prestigious scientists in the United Kingdom and, indeed, the world. They produce some very good reports and we should use them whenever we can. Similarly with the Royal Academy of Engineering and, indeed, others.

436. Let me put this point to you. Of the 14 reports I have recorded up to May 1992, what use has been made of these? How have they turned out to be of practical value? Have you looked at them? Have you assessed them?

(Professor Stewart) Yes.

437. Or have they all gone on to the shelf?

(Professor Stewart) No, they have not gone on the shelf. has generated some useful reports. Secondly, let me say that government has taken note of the inputs that ACOST make and Robert Foster will give you one or two examples of when that has happened.

(Mr Foster) Can I give you an example. In the DTI before., I was responsible for the EUREKA collaborative programmes. There was a major report done by ACOST on EUREKA. There was a

[Sir Trevor Skeet *Contd*]

lot of concern that the United Kingdom was not participating sufficiently and there were some very helpful proposals made by ACOST. Those were put to DTI ministers at that time and were acted upon. United Kingdom participation has increased by a factor of three and last summer it had the largest number of participants in Europe in EUREKA projects on an annual basis. In many ways ACOST was one of the triggers behind that improvement.

438. But that could have been decided by the ministry themselves, in the Department of Education and Science. If they had thought about this deeply they could have done that without all this reference.

(Mr Foster) ACOST helped on the difficult problem of priorities for limited Departmental Resources.

(Mr Wilkinson) I suppose one cannot prove a hypothesis but perhaps had there not been this gingering from ACOST the government departments would not have done it. One function of an advisory body is, of course, to ginger up the system and I think it is fair to say that left to our own devices some government departments might not get there perhaps as quickly, without that external impulse.

Dr Bray

439. Is not the difference between the Government's own advisory councils and the Royal Society and the Royal Academy of Engineering that Government appoints its own advisory bodies but it does not appoint the officers and council of the Royal Society and the Royal Academy of Engineers?

(Professor Stewart) That is true.

440. Therefore, if Government wants a wholly independent view or is forced into asking for a wholly independent view, is not that the kind of question on which the Royal Society and the Royal Academy of Engineering should be approached?

(Professor Stewart) I think that is right.

441. But then when Government wants to have the advice deliberately fitted into its broader framework of policy—and every government has broader frameworks of policy and science and technology works within that—are these not questions for which the Government has to have its own appointed advisory body?

(Professor Stewart) It has it in that sense, and also it has in-house officials, some on secondment.

442. The ABRC and ACOST were departmentally separated before and now they have been brought together, is it not the case that in fact when you look at the actual people the science and technology community is really quite a small community and most people talk to most other people and it is really a network that one is tapping by whatever structure one has?

(Professor Stewart) Yes.

443. Therefore the effectiveness of an advisory structure surely depends upon its method of working, the way the chairman works, the way the Committee structure is set up, the way temporary working groups are created and things like that.

(Professor Stewart) Yes.

444. Would these not need to be modified from time to time depending upon the questions addressed, as you have just said?

(Professor Stewart) Yes, I agree.

445. Is it not the case that some of those functions would be confidential advisory ones which Government needs to make its mind on before the advice is published, if the advice is ever published, and some would have to be publicly reported? Does that not all define in fact a fairly practical and straight forward development of the advisory structure?

(Professor Stewart) I think we have to wait to see what comes out in the White Paper. I would simply say that I have found your comments very interesting. Secondly, let me say I have to give credit to ABRC and ACOST who in the past have provided very valuable advice and there are some very good members on them.

Chairman: We will certainly look for signs of impending change when the White Paper is finally with us.

Mr Williams

446. When it comes to these advisory bodies, is not the composition of them rather restrictive and narrow? I understand ACOST does not have any women representatives on it, and this Committee has three, and it has no trade unions, consumer groups or environmental groups represented. Should not the advisory bodies be more broadly based to take account of the needs of society, the environment, women and trade unions?

(Professor Stewart) You are raising a very fundamental point here and that is whether you should have, for example, the statutory Scot. Sometimes I think I have been the statutory Scot —I would like to think if I was put on committees I was there not because of my nationality but because I had a positive contribution to make. I believe that should be the most important overriding factor, whether it is women, whether it is ethnic minorities or anything else. But I do think nevertheless it is terribly important that one gets a broad spectrum where one can get that. You have touched on the question of women in science and I am not sure whether it is going to come up again or whether I should answer it now?

Chairman

447. Answer it now.

(Professor Stewart) Clearly over 50 per cent of our population are women and as such they are an increasingly important intellectual resource. We

[**Chairman** *Contd*]

have always had extremely able women—in science. For example, Barbara McLintock who discovered jumping genes in the US and got a Nobel Prize for it. In this country we have had people like Irene Manton. I remember she lectured to me when I was a young scientist and made a lasting impression upon me. She was a Fellow of the Royal Society. We have youngsters today who can do that—Sue Kingsman from Oxford. Jean Thomas is a Fellow of the Royal Society. As the pace of science and technology changes and as one moves away from the needs, if I may say so without disrespect, of physical strength to intellectual strength, women will play an increasingly important, and must play an increasingly important, role in the whole of science and technology and in society generally. We have to address this positively, we have to address attitudes, we have to address cultural change et cetera, but we have also got to put in place mechanisms which allow people who have different personal circumstances to benefit as much as possible from the area and opportunities of science and technology. Let me say it is quite difficult in some areas of science—if you are an experimentalist and you have an experiment which runs over 24 hours, it is difficult to have a part-time scientist on that job. We have to find more mechanisms where we do take account of the needs of part-time scientists and technologists, women and different groups in general. This is an area I hope the Office of Science and Technology will address.

Mrs Campbell

448. I think you started, Professor Stewart, by saying you would want to feel if you were on a committee that you were there because you had a positive contribution to make, are you implying by that there are no specially qualified women who could make a positive contribution? I am sure you did not mean that and will tell me you did not mean that, but are there no specially qualified women who could make a positive contribution to advisory councils? Perhaps you would like to comment on another observation of mine: during the course of this inquiry we have not had a single woman appear before us as a witness. You might like to comment on that.

(Professor Stewart) I could comment on the latter—perhaps you have not asked them!

Chairman

449. Maybe.

(Professor Stewart) On the question of the advisory councils, I agree it is important. In fact let me tell you ACOST has in the past tried to appoint women and they have turned us down. So we do work at it but we have to work at it more in the future. It is something which the Prime Minister takes a particular interest in. You will know as part of the work of the Citizen's Charter that Nancy Lane from Cambridge is looking at the question of women in science. Indeed I am meeting with a group of them in my office—probably you should come along—next week I hope that we will work closely with Nancy Lane in this area. So we are at one I think on the importance of women in science.

Mrs Campbell

450. Can I take up the other point you made about part-time arrangements? It is not only women who should be considered for part-time arrangements but men as well because unless you are prepared to give or create the sort of circumstances in which men as well as women can work part-time then women are always going to be taking the full responsibility of doing both the domestic work and trying to run a scientific career alongside it, which is pretty impossible. So there has to be a change in the structure for men as well as women. It is not just women, with respect, you should be talking about in this respect.

(Professor Stewart) I did not mean that and I hope I did not imply that. I can tell you there are as many males as females who would like part-time careers.

Mr Powell

451. I have no doubt your department will take note of the fact that 30 per cent of this Committee are women and our clerk is a woman. However, you constantly talk, not only in this part of your evidence but all morning, in futuristic terms; "these are issues which need to be addressed". You do not give us any impression at all that they are currently being addressed and what difference the establishment of this department has actually made to how these matters are currently being handled. All we get is "everything is postponed until after the White Paper", this cannot be right.

(Professor Stewart) I have just said to you that we are bringing in a group of women this week or early next week. Is that too futuristic?

Mr Williams

452. A follow-up on this: generally in science and industry the public's perception, especially amongst young people, is that there is a conflict with the environment. Should not some body like Greenpeace, Friends of the Earth, the RSPB, the WWF, a whole host of voluntary organisations like that, be involved in the advisory groups and look to the future and care for the environment and lessening the part industry has in this? This is a large growth area, should not environmental organisations also be in these advisory bodies?

(Professor Stewart) I agree with you that such groups should have opportunities to contribute and be on committees. I used to sit on the Royal Commission for Environmental Pollution and there are lots of environmental groups and there are woman representatives on occasion on some of them. I do not have the facts and figures with me. I think that our concern is that of main-stream science

[**Mr Williams** *Contd*]

and technology. Environmental groups will focus on some of the environmental committees that the Department of the Environment will have; agriculturalists will predominate in departments that the Ministry of Agriculture will have, and our role in the middle is to try to make use of the best scientists and technologists there are, irrespective of whether they are environmentalists or industrialists.

Chairman: Can we turn now to education and the provision of trained personnel. Mrs Campbell?

Mrs Campbell

453. You may feel this is something that is more the responsibility of the Department for Education, but in my opinion schools tend to value literacy far more than numeracy and there is a whole tendency to lessen perhaps the influence of scientific education. I think there is a very worrying trend at the present time with the number of youngsters staying on to study science A-levels as opposed to arts A-levels and universities are increasingly finding themselves having to accept lower grades in order to fill their courses in some science areas, particularly in engineering. What role do you think the Office of Science and Technology can play in all this and are there any ways in which you are already addressing the problem?

(Professor Stewart) Let me say as an introduction, then I will turn it over to David Wilkinson, that yesterday, for example, we were discussing these very types of issues with the DFE because, as you said, this is an area which is of interest to them.

(Mr Wilkinson) There are indeed reforms in train addressing this problem, the introduction of the national curriculum, the reform of vocational qualifications to try and establish parity between the academic and the vocational, and these are matters that have been taken on by the Department for Education and remain, as you say, their prime responsibility. Of course, we are very interested that they should succeed but the one thing that I would say is that one is naturally impatient to see the results coming through. However, I think it is fair to say that in the attempt to ensure that all schoolchildren study mathematics and science through to the age of 16 at least and do not specialise even earlier than that, all the people engaged in the debate have acknowledged that this would take time to feed through and it will be the next millennium actually before children who have studied the entire national curriculum throughout their 12 years will begin to come through. So the long run for once in the United Kingdom is being addressed. Nonetheless, as you say, there do seem to be interim, intermediate problems. In terms of trying to encourage more people to go into A-level and then on to university reading sciences and engineering, as part of the Autumn Statement last week the back-up statement by the Secretary of State for Education invited the Higher Education Funding Council for England to address this question and in particular invited it to come up with a funding formula that actually provided more incentives for institutions to recruit in those areas. So the signal to the providers of education is, "If you can attract recruits in these subjects you earn more money". Of course, beyond that what we are looking at are key market signals: "we actually want engineers and scientists, and if you qualify in these subjects there is work, careers and prospects for you". The position there is still far from clear. So those things are happening. I am sorry to give such a long response, Chairman, but we are into one of these terrible culture changes.

Chairman

454. Can we make clear that also, of course, leaving aside for one moment the point of the science base and the importance, as it were, for the development of science which Alan raised, you have also touched on there the suitability of the graduates of today for industrial employment. I take it from what you just said that that too is part of the remit of the Education Research Council or whatever to address. Is this so, because there is an overall feeling that there are not enough graduates qualified in a suitable way to join many of the industrial opportunities that do exist?

(Mr Wilkinson) I think there is a range of shared responsibilities here. The Department for Education leads for first graduates but the post-graduate provision is a matter that the Office of Science and Technology will need to address with the research councils, certainly in the science and technology area. Of course, the humanities and the arts remain with the Department for Education

Chairman: Understood.

Lynne Jones

455. In view of the decrease in the unit costs now of producing a graduate in our universities and the continuing pressures in that direction, are you concerned about the quality and standards of the graduates being produced by our system? I have in mind some comments that were written to *The Independent* by Earl Russell on this.

(Mr Wilkinson) Again if I can plead this is primarily a matter for the Department for Education, in setting up under the 1991 Act the new Higher Education Funding Council, arrangements are now being made to set up quality assessment units so that the actual quality of teaching and education in our universities will be looked at by this group for the first time, and obviously they will want to know—— Sorry, I say "obviously" but I assume one of the key things they will want to know is what the main users of the output see of the quality of graduates over time. So that question is one which has been identified as valid and needing to be addressed and it is being addressed by the Department for Education under this new machinery.

Chairman

456. Can I turn, Professor, to the question of career structure for research scientists, assuming we get the scientists into the universities and they are

[**Chairman** *Contd*]

capable of entering careers in research. There has been quite a lot of criticism amongst those who have given evidence to this Committee, and I think both the Royal Society and ACOST were concerned, that there seemed to be a lack of career structure for research scientists. I think also the Association of Pharmaceutical Industries was concerned about the short-term nature of research contracts, which meant there was short-term funding of projects. Is this an issue? Do you feel from other sources that there is a genuine concern about this and are short-term projects, under-funding research and the lack of academic career structure inimical to the development of science that you want to see take place?

(Professor Stewart) Yes.

Lynne Jones

457. Are you concerned that we are losing some of our best post-graduates from science and they are entering into other areas where the career structures are more attractive? Is any work being looked at on that, especially in view of what has happened to university salaries?

(Professor Stewart) I agree that there is a problem with career structures and it is something which the White Paper will almost certainly address. I would be very surprised if it does not. You raised a slightly different question about whether some of these scientists are going into other areas. If they are going into industry I do not have any concerns at all. Perhaps we need more of them in industry and maybe we need more of them in society generally. I do not see why a BSc degree should be any different from an arts degree. They should be able to take on a variety of posts in the future. I think the question we should be asking is whether the actual training that they get—and let me talk about higher degrees because I know that area better—whether the breadth and balance of what they are getting best fits them to the needs of the future. I think that that is a very important area to address.

Chairman: Can we turn now to Europe and European programmes?

Mr Powell

458. There is a lot of criticism in this country that it is difficult for Britain to participate as fully and effectively in European research programmes because of the requirement under the Treaty of Rome for what is nowadays called "social cohesion", and therefore the actual benefit which is likely to be derived to Great Britain from participation in such programmes is minimal. Is this a view you share?

(Professor Stewart) I am going to ask my colleague to answer.

(Mr Foster) The key objectives of the Framework programme are industrial competitiveness and improvements in quality of life. In selecting proposals the Commission and its advisers look at the best proposals from whatever source they are. Having said that, quite clearly there are some programmes which are, you might argue, closer to the market for example those in which small and medium-sized companies are encouraged to take part. There are some people who say the quality of some of those programmes is not as high as, say, the ESPRIT programme. Thus in programmes like BRITE and EURAM there are a lot of Portuguese and Greek companies taking part, and these include an aspect of social cohesion. However, in general most of the programmes are organised to be on the basis of excellence. So in the broad, we think they are aiming for industrial competitiveness, and that social cohesion is not a key objective.

459. A little earlier you were talking about EUREKA and your own involvement in the EUREKA programme and how as a result of advice, some of which may have been external advice from ACOST, the British Government was able to make a significant change to the nature of the programmes and there was a much higher British participation. Is this something which can be replicated through the range of European programmes to which we subscribe?

(Mr Foster) I think that is a very good point. If you look at what was needed to improve EUREKA the key thing was to make information more widely available to UK industry, so the latter knew what was available. One of the concerns with European Community programmes is whether companies know, and not just companies but universities too, what opportunities are available. Secondly, when European research has been done, is there sufficient technology transfer from those involved in the programmes to other organisations who are not actually involved? There I think there is a major problem. There is a need for greater dissemination of information on opportunities and subsequently greater dissemination of results and technology transfer. The UK is actively putting in proposals to the Commission on how to improve the position.

460. Is actively putting them in?

(Mr Foster) Yes. To give an example, next year negotiations will take place on Framework programme 4. The UK, along with Germany and France, has put in detailed papers which have been made publicly available on how we think this programme should be shaped. We have stressed in particular the importance of standards for marketing opening in Europe. We are now working on proposals to the Commission on how management of the programme should be improved, including how the technology transfer arrangements should be improved.

461. Are there any particular difficulties which arise particularly in relation to universities being discouraged from participating in EC programmes due to financial problems like Treasury rules on attribution and the fact the European Community only allows 20 per cent for overheads on research projects?

(Mr Foster) There are a number of different issues you have raised. The first point is that universities

[**Mr Powell** *Contd*]

are clearly very attracted to taking part in European Community research programmes. UK higher education institutions are more active than those from any other major EC country in taking part. So they clearly want to take part and are seen to be participating very effectively, including some of our leading universities. Secondly, there is concern by a number of UK universities on the way the Commission interprets overheads which is different from the way they are interpreted in the UK. There is an on-going discussion on this. The Higher Education Funding Council for England has been looking at that issue as part of consultations on research funding, and I am sure we will be putting a strong input into the Commission on that very point. The attribution issue which you mentioned, is really rather a different point. At this stage universities as such are not being put off due to attribution rules.

Chairman: Could we come to the final question and go back to the role of the OST?

Dr Bray

462. You discussed earlier the activities of Government departments in your own research programme and your own role and then questioning or examining it. Are you the chief scientific adviser, Professor Stewart, to the Government? Are you the Government chief scientific adviser in the sense in which the head of the Central Statistical Office is the head of the Government statistical service? Are you chief scientific adviser to the Government?

(Professor Stewart) I am Chief Scientific Adviser to the Prime Minister and the Cabinet.

463. And the Cabinet? Or are you chief scientific adviser to the Prime Minister in the Cabinet Office?

(Professor Stewart) I have not got the actual wording in front of me.

(Mr Wilkinson) I think you are to the Government.

Chairman: There seems to be a general consensus you are chief scientific adviser to the Government.

Dr Bray

464. Would it not help if you were clearly described in the Civil Service list and elsewhere as the Government's Chief Scientific Adviser?

(Professor Stewart) I think what we have done is set up the Office of Science and Technology, the Office of Science and Technology has then to be followed by a White Paper which takes aboard a variety of these issues, and in the outcome of the White Paper we will try no doubt to fine-tune and address various issues which come up under this. If this is an issue which you think is important, I am sure that would be looked at.

Chairman

465. I think the Committee were of the opinion, Professor, when we last met you that the importance of the new development and the importance of the Chief Scientific Adviser must be assured in whatever way we can so assist. You look to our report for evidence as to the way in which we are going to assist you. May I thank you, Professor Stewart——

(Professor Stewart) Before you end, Chairman ——

466. A valedictory answer.

(Professor Stewart) I wonder if I may say one or two things. I want to come back on the question of "futuristic" because you have struck a chord with me. The Office of Science and Technology has been set up for eight months, we have to be forward looking in relation to that. Let me simply make that point. Secondly, the White Paper will clearly be the next step after setting up the Office of Science and Technology and clearly the advice that I give has to be advice to my Chancellor and to the Prime Minister. Thirdly, we did not cover industry and the interaction with industry perhaps as fully as we might have done, and I would therefore suggest that if any of you have not done so you should look at a recent article in the *New Scientist* which took aboard comments by industrialists. There was a major article by Andy Coughlan which inputted strong views from industry on what the Office of Science and Technology should be doing. It makes four interesting and very supportive comments on OST. I think the *New Scientist* is closer to the mood of the S&T community in this country than virtually any other S&T based weekly, and maybe you would want to look at that. Finally, Chairman, perhaps I can leave you with a comment from Sir Bernard Cox who wrote in the *New Scientist* in 1973, "a committee is a cul-de-sac down which ideas are lured and then quietly strangled".

467. Is that a personal observation of this Committee?

(Professor Stewart) Certainly not! I am sure, Chairman, your Committee will reflect fully on our ideas and they will not be strangled here, but importantly, Chairman, I hope that you will seek to ensure, as best you are able that they are not strangled elsewhere.

Chairman: Thank you very much for that wise advice!

THURSDAY 19 NOVEMBER 1992

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mrs Anne Campbell
Cheryl Gillan
Lynne Jones
Mr Andrew Miller
Sir Trevor Skeet
Mr Alan W Williams

Memorandum submitted by Advisory Council On Science and Technology (17 September 1992)

1. ACOST gives the Government independent advice on science and technology issues. Its full terms of reference are:

"To advise the Government on

- Priorities for science and technology in the United Kingdom.
- The application of science and technology, developed in the United Kingdom and elsewhere, for the benefit of both the public and private sectors in accordance with national needs.
- The co-ordination, in collaboration with Departmental advisory bodies, of science and technology activities.
- The nature and extent of United Kingdom participation in international collaboration in science and technology.

To publish reports as appropriate."

2. The Chairman and members of ACOST are appointed by the Prime Minister, usually for a period of three years. The Council currently has 18 members of which half are senior industrialists and half eminent academics. The chairman is Sir Robin Nicholson, an executive director of Pilkington plc and a former Chief Scientific Adviser.

3. The Council normally meets six times a year and Government Chief Scientists attend as assessors. Most of the detailed work is carried out in Working Groups, the membership of which is drawn partly from Council and partly from co-opted members who have special expertise in the subject under consideration.

4. Most of ACOST's work is initiated by the Council itself, although some is undertaken at the Government's request. All advice is initially confidential although permission to publish is usually sought. Such permission has always been granted.

5. The ACOST Secretariat is located in the Office of Science and Technology in the Office of Public Service and Science. It comprises a G5 Head of Secretariat and 4 G6/G7 Secretaries together with 5.5 support staff. All senior staff are on loan from other organisations for 2-3 year periods whilst the support staff are permanent OPSS employees.

6. The work of ACOST is funded through the PES system. Members do not receive fees and the major elements in the budget, which for 1992-93 is approximately £475K, are Secretariat staff costs and GAE.

Examination of Witnesses

SIR ROBIN NICHOLSON, FEng, FRS, Chairman, DR J MCGUINNESS, Head of ACOST Secretariat and MR D LOBLEY, ACOST Secretariat, Advisory Council On Science and Technology, were examined.

Chairman

468. Good morning, Sir Robin. Thank you very much for offering to come to provide an oral evidence session to us. I appreciate this has not been easy and the time constraints have been severe. As you will equally know we have your good self and Sir David Phillips this morning but the Committee is extremely grateful that you should have found time to come. You will be aware that the evidence submitted by your good self, and indeed by Sir David, to the Chancellor of the Duchy has been made available to us, I have to say in defence of my colleagues and myself, only extremely recently so while we are facing the author on the matter the readership is slightly more slender. Therefore you must excuse us if we ask questions from only the hurried assessment that our advisers and ourselves have been able to give. We have our name plates here and may I start by asking you if you wish to make any opening statement and to introduce your colleagues.

(Sir Robin Nicholson) Thank you very much, Chairman, for those words. It is, of course, a great pleasure to appear before this Committee and it was easy to make the time available. I am accompanied by three of my colleagues from the ACOST secretariat, Dr McGuinness, Mr Lobley and David Schildt somewhere behind me. As you say, Chairman, you had I think at an earlier stage a copy of our ACOST Triennial Review and you very recently received the advice that we gave to the

[**Chairman** *Contd*]

Chancellor of the Duchy for his White Paper. Because it is so recent, I wonder if you would permit me to spend two or three minutes to summarise some of the key points. ACOST, put very simply, has three concerns. The first is what contribution can science and technology make to wealth creation? The second is what contribution can science and technology make to the quality of life and other societal needs? And thirdly what is the health of science and technology in the United Kingdom? Our remit is very broad—we cover the whole of government activity in science and technology and we have a correspondingly broad membership drawn from all walks of scientific and industrial life and I think this pervades the advice that we gave and I hope that feeling comes out in it. We were also encouraged by the Chancellor of the Duchy to take a "green fields" approach in our advice which we did with some relish; it is always nice to be given that instruction and we concentrated on the structure of the science and technology system. Many of our previous reports have covered particular subject areas such as priorities in funding and things like that but we were able to concentrate on structure on this occasion. Really what I would like to say to your Committee then is just to identify four key problems and four solutions which we are proposing. The first key problem is that we believe that historically the British science and technology system has been too inflexible to meet the demands placed on it. We live in a rapidly changing world and there is always a need to channel resources from place A to place B and next year from place C to place D. We felt the system was not responding with sufficient flexibility to do that. It is difficult to stop expenditure in old areas and start channelling it into new areas. We felt too much expenditure follows historically the ownership of particular research providers. Our solution to that is to clarify three levels. The first is the policy level—and I mean policy overall much of which is not concerned with science and technology. The second is called the executive funding level which has the job of taking those policies and either funding the science and technology needed to put them through or else funding adequate research and development. The third level is the research provider, the people at the bench pushing forward the frontiers of science and technology in accordance with the funding which has been given to them. Thus we feel that the clarification of that will help to make the system more flexible and more responsive to need. The second problem is that we felt that the criteria for so-called "basic" and so-called "applied" research had become very muddled and we took a close look at this subject and decided that the definitions would be much better if they reflected better the motive for doing certain pieces of research and development. We therefore distinguished between what we have called "curiosity driven research" and "mission oriented research" and experimental research and development. These names are not new but we feel they are a better indication of the motivation for doing research. We propose therefore that the curiosity driven research should be the remit of the council which we have called the "Council for the Advancement of Scientific Knowledge", which would be inter-disciplinary and which would fund research in accordance with pure curiosity and without regard for the moment to immediate relevance. Then we suggested on the other side that there should be a series of mission orientated programme directorates with an umbrella organisation which we have called the "Council for Mission Orientated Research" which would be funding research for particular missions: the mission of wealth creation; the mission of the nation's health; the mission of our environment and things like that—but very clearly mission orientated. Since this material has already begun to be misinterpreted in public I think I would like to just make three explanatory comments on this.

The first is that mission orientated research does, of course, require fundamental research. All of us who are involved in mission oriented research, whether in industry or government, have occasionally come up against problems where we lack the fundamental knowledge and we have commissioned fundamental research to solve that problem. There is no intention to leave out fundamental research from the mission oriented research approach. Secondly, there is no intention to separate curiosity driven research and mission oriented research at the level of the search provider. The all important stimulus we have, about which we all agree is at the research provider level and which needs an understanding and a free interchange of ideas between people doing curiosity driven research and people doing mission oriented research. Finally we feel it is very important that research providers have a substantial element of continuity in their funding. If the phrase was not used to describe other things I would call it "dual funding". There needs to be base line funding in order to support certain long-term programmes of work as well as project based funding to solve particular problems. We feel that that is a general principle which should be applied. Moving briefly now to the last two problems——

469. Sir Robin, we have a limited amount of time so perhaps you would be coming to a brief conclusion.

(Sir Robin Nicholson) I will indeed. The third problem is the lack of a national strategy in science and technology and fragmentation of research objectives between publicly funded and privately funded R & D. We feel OST has a major role to play here. We are in favour of a strong OST and have indicated in our report how it can meet those objectives. The fourth problem—which I know your Committee has examined already—is that there are too few world competitive technology-based companies in the United Kingdom. We feel that a number of the programmes which have been developed by the DTI, such as LINK, such as the Teaching Companies Scheme, are excellent and should be increased, but we believe they should be built into the structure more and believe that, by promoting these programme directives where funding can come from OST, it can come from

[**Chairman** *Contd*]

government departments and from the private sector, we are actually getting our act together, in the phrase that people always use, and there is a possibility of a joint approach and not a fragmented approach. We think that by leveraging public money and private money that will make a major contribution to the capability of United Kingdom industry where it is science and technology based. There are other areas I will not mention—Europe and advisory structure—because I am conscious of the short time.

470. We are grateful. Thank you for that. We do have a number of questions. Can I start off with one which relates to what you say. We have had a lot of evidence given to this Committee of the unsatisfactoriness, or apparent unsatisfactoriness, of technology transfer. As an industrialist, what do you think of the weaknesses in the current system? How can they in your view be improved and what should OST's role be in all this?

(Sir Robin Nicholson) I think one has to look at technology transfer in different types of industry. I know you have had discussion already in the proceedings of your Committee about the Glaxos on the one hand and small start-up companies on the other. Technology transfer is obviously very different for those. By and large the large companies can look after themselves; they know well the science base in the universities and run their own technology transfer. Where we feel the gap is is in the medium and smaller sized companies, and we are one of many organisations who have almost simultaneously proposed the Faraday concept, in which there would be developed centres of excellence in particular technologies which would bridge the gap between the science base and engineering base on the one hand and the industrial need on the other hand. We see this fitting naturally into the structure which we have proposed in our paper and we see the role of OST as being to take an overview of technology transfer and to ensure that of the total funds available adequate funds go into technology transfer so that we do not over-produce knowledge and under-transfer it, which is what I think we tend to do at the moment.

Sir Trevor Skeet

471. Sir Robin, you have been talking about a multiplicity of organisations; you are thinking of bringing into being additional bodies; your own organisation had a predecessor known as ACARD, that moved away and you came up. Do you think you can bring about better technology transfer by this system?

(Sir Robin Nicholson) I think there are two questions there. On the first, as far as advisory structure is concerned, you are absolutely correct: ACARD which tended to look at specific technologies was replaced by ACOST and even during the lifetime of ACOST we have changed our methods of operation quite substantially in order to have broader-based strategic reports with much more of the work being commissioned outside. You may want to return to that subject later. With regard to the structure we are proposing, we are really replacing a current structure with a new structure. I do not believe it is more bureaucratic or more complicated; I think its key features are, firstly, that it recognises the vital importance of curiosity-driven research. I must say the industrial members of ACOST are just as strong on this point as, if not stronger than, the academic members. Secondly, it allows, through what we call CMOR, the programme directorates, for the private sector, government departments and OST, to collaborate naturally together and pour their funds into specific programmes in order to achieve certain missions. I think it is actually a simplified structure and has inherent in it some of the excellent characteristics of the Teaching Companies Scheme and the LINK scheme.

472. Sir Robin, you have brought out some very learned papers—I have counted them up, ten in number—and I see you are Chairman of CEST as well.

(Sir Robin Nicholson) No.

473. You have some connection with CEST?

(Sir Robin Nicholson) I was the first Chairman of CEST but Sir John Fairclough has been Chairman of CEST for three years.

474. You then brought out something like 33 learned papers. Has all this information drifted across to companies to assist them in new technology?

(Sir Robin Nicholson) I think ACOST and CEST are very different animals. As of course you are well aware, ACOST is looking broadly at strategic issues whereas CEST was set up largely with private sector funding to look at opportunities in particular sectors of industry or science like communication and the environment. What it has done, I think very well —I say this, I am no longer and have not been for some time closely involved with CEST—has been to match societal needs with scientific opportunities and it has done that in those areas which are of most interest to people funding CEST, primarily 80 per cent of which is private sector. If those people did not feel it was doing a worthwhile job they would not be paying their subscriptions. Most have just renewed their subscriptions.

475. One further point: I happened to open the paper this morning and found that the fast breeder reactor research work is to cease completely so far as the United Kingdom is concerned. This must have come through one of the bodies in which you made recommendations—I think your body, ACOST, which looked into the Sizewell reactor. Therefore, I dare say you have gone into even broader fields. How can this recommendation come forward now? Is this for the benefit of the community and the creation of wealth?

(Sir Robin Nicholson) Two comments on that. First, as far as the Sizewell reactor was concerned, the ACOST concern was whether building that type

[Sir Trevor Skeet *Contd*]

of reactor would have such a great impact on industry in the United Kingdom as would the continuation of building of AGRs. We concluded it would not. As far as a fast reactor is concerned, ACOST in giving its priorities advice to government has generally taken a fairly negative view on further research on the fast reactor. Our judgment has been that it is unlikely ever to be commercially viable and so I do not know what members of ACOST would think about the announcement in today's papers, but I would guess they would be supportive of it because I think there are other more important things to do research on.

Cheryl Gillan

476. Sir Robin, I am interested in the practical side. Everyone is agreed we should be establishing national priorities in science and technology. What is your experience of establishing these in practice through ACOST? Do you find it easy to reach agreement on the priority areas for industry or do you find they are subject to a wide variation of views and prolonged discussion and, dare I venture to say, argument on occasions? What is the practical side of this?

(Sir Robin Nicholson) We have quite spirited, and at times heated, arguments within ACOST, as you would expect, I think, from the very broad base of people who are there. It is not easy to form priorities and I think that what we are suggesting is that our structure provides a more natural way of establishing priorities than a group of people sitting round a table. What we are saying is, by bringing together OST funding and government funding and industrial funding, the priorities will emerge because people will agree that a certain area is extremely important for further research. Let us take a particular example, concern about food safety, which has come up very much in the last few years: there are a lot of people who have an interest in food safety. The Research Council has done excellent fundamental work in microbiology; government departments, the Department of Health and MAFF, have an interest in it; and our producers of processed food—the Unilevers of this world—and the purveyors of processed food—the Sainsburys of this world—all have an interest. I think the structure we are proposing would naturally allow that priority to merge in a rapid way and resources could quickly be funnelled into it. So I think there should be a convergence of minds in the structure which we are proposing which I think is superior to people sitting round a table arguing about it. But at the moment in ACOST when we advise the government about priorities we do sit round the table and try and reach a consensus. We have not had any minority reports but I suppose it would be fair to say sometimes our advice is less sharply defined than I would like because we are trying to bring in a variety of points of view. But really the most effective way of determining priorities is when people are prepared to be made accountable. For and our structure allows that to emerge quite naturally.

Mrs Campbell

477. Mine is a supplementary following on from what Cheryl Gillan has just said. As I am sure you are aware the United States have undertaken an extensive list of critical technologies in connection with defence diversification. Do you think we should be doing the same thing in this country and have you given any advice to the Government along those lines?

(Sir Robin Nicholson) Yes, the formation of CEST was a direct result of an ACARD report which looked at the foresight basis of some of the excellent work of SPRU. I think one of the things about the lists of technologies is they do tend to be remarkably similar from one country to another and I think it would perhaps be worrying if they were not. I think it is the stage beyond that I am concerned about. It is not difficult to identify bio-technology, advanced materials and membrane technologies. It is not difficult to do that and, as I said, most countries do. I think it is a stage beyond that, which part of what science is needed to be input into it? What are the missions? What are the outcomes of that piece of research? Where there is a mechanism for what we have described and people placing money for which they are accountable in particular areas, then the right set of priorities within those key technologies do emerge to help people. We say in our report that it is extremely important that the country has available to it skills in these generic technologies. The fine detail of those skills has to be worked out in the way I have just described but there has to be a broad base of these skills. We have proposed in our report a concept of generic technologies where it is totally appropriate for government-funding because it is going to be widely available to industry and to society as a whole. We believe that the concept of generic technologies as distinct from separate programmes is a much more valid and constructive criterion for government-funding than the near- market/far-market philosophy which I think is now largely discredited.

Chairman

478. What are the benefits in your view that encourage large international firms to locate their R&D in the UK rather than elsewhere?

(Sir Robin Nicholson) I think the most important factor is the quality of the people available in the United Kingdom. I think certainly the companies I have been associated with and foreign companies which I know have placed that top of the list. I think obviously the position of the United Kingdom in the European Community is extremely important as well. If we were not in the European Community I do not believe we would get that investment. Also the more mundane point that the English language is not a disadvantage because it is the lingua franca of science. But I think the key thing is the availability of highly skilled people.

479. In your view that is still a satisfactory asset and we have sufficient of them?

[Chairman *Contd*]

(Sir Robin Nicholson) It is still an excellent asset. We must never be complacent about it and I think that is why ACOST has taken such a strong view on the science base and funding for the science base because the primary output of that expenditure is skilled people. The UK measures an output in research as well but the primary output is highly skilled people.

Mr Miller

480. Leading of from that and I know this is not necessarily an area of your mainstream activities but many would say that the UK tax system does not do enough to encourage R&D. How significant an influence do you think it has both on R&D expenditure of companies and on any multinational companies which might be considering basing its R&D here?

(Sir Robin Nicholson) Well, I have had the privilege of many stimulating discussions with Dr Bray on this subject. ACOST has considered it on a number of occasions and has never been convinced that a broadly-based tax incentive scheme is cost-effective compared with other things which might be done. I am not, of course, saying it would have no effect. Obviously if one did move towards the Australian or American system it would have as big an effect. I think ACOST takes the view that it would not have as big an effect as other ways of spending that amount of money. In our advice we have actually proposed very focused and directed tax incentives for cooperative research in order to stimulate the sort of structure that we want to see by involving programme directorates. We are saying industry's contribution to these collaborative programmes should be given special tax consideration. I think there may be a case for that and I am sure there are other ingenious schemes one could draw up but we are not convinced that broadly-based further tax relief over and above what we already have would be cost-effective. I do not think it is a particular feature in determining whether international companies locate their R&D compared with the things I mentioned previously.

Mrs Campbell

481. Sir Robin, you are a supporter of the customer/contractor principle that has been government policy for some decades now. But you are proposing a separation between policy makers, executive funding bodies and research providers. Do you think this proposal is flawed in view of the fact that OST will both be the ultimate source of funds and of policy and may well be wishing to direct executive funding agencies. How easy do you think it would be to maintain that principle in practice?

(Sir Robin Nicholson) Two things. Although you rightly say Rothschild is some 20 years old this year we must not confuse that with Rothschild being implemented. It has not been effectively implemented in many areas and I think a lot of what we are saying, if Lord Rothschild was still alive today and read it he would give a yawn and say, "I said all that in 1972." We do not think it is any worse for that. What we are looking for is the structure for implementing it. We see the role of OST at the top level defining national strategies and saying, "We want these things to be achieved." We would then expect it to allocate funds to the bodies in the second level to achieve these objectives. Now I think it would be possible for OST to straddle level one and level two. I think there are pluses and minuses to that. I think the pluses would be greater coherence and possibly less bureaucracy. The minuses would be possibly too much centralism and too much direction. What we would like to see is the OST looking at strategy and defining the balance. Let me give you some examples of that balance: the balance between curiosity driven research and mission orientated research; the balance between base line funding and proposals orientated research; the extent to which OST puts its pounds where industry is putting its pounds in collaborative research. We see it as a balancing activity which we do not think has been easy to do in government because of the lack of an OST. So we see it at a strategic level and balancing level and then we see the level two funding agencies carrying that out in order to fulfil OST policies. On balance we would see OST firmly in the top level and not in the second level. We would see in the second level, the executive funding bodies we mentioned, the councils and the Higher Eduction Funding Councils and so on.

482. Can I come back to the customer/contractor relationship. I think you have recognised that there should be a stable long-term relationship but in the evidence that we have collected it has been recognised, I think, that one of the most successful relationships between research councils and departments is the relationship between the MRC and the Department of Health. Really one of the most successful collaborations is the study into mental illness and the effect on the National Health Service of how this burden can be reduced, if you like, or treated most cost-effectively. The MRC and the Department of Health have really abandoned that contract relationship in the way they have worked. I am not sure whether you are familiar with it. It is an example of a relationship where the customer-contractor relationship has been shown not to be the most effective, and I wonder if you have any comments on that?

(Sir Robin Nicholson) I think the customer-contractor relationship was misapplied in the early days in the Department of Health. I think it is now back to a much purer system. The Department of Health, as I see it, is totally responsible for setting policies and strategies, for example, in mental health, as you mentioned. The Medical Research Council is responsible for funding research to meet those strategies. I was talking actually with Dr Rees only the day before yesterday about this. He described to me the way in which the Department of Health and the Director of Research, Professor Peckham, and he interact on this subject. I think the

[**Mrs Campbell** *Contd*]
MRC and the way it operates with the Department of Health, level 2, level 1, is actually a model for what we are proposing. It is excellent.

Chairman

483. You do not want Research Councils to turn themselves into funding institutes. When you have a nice cosy contractor relationship over a period of time you become interdependent, do you not?

(Sir Robin Nicholson) I think we do want Research Councils to fund institutes, we do not want Research Councils to own institutes and be their sole source of funding. We believe that has led to inflexibility. If I give you an example on a positive basis, the Royal Signals and Radar Establishment at Malvern is the best laboratory of its type in the world, but because it has been owned by the Ministry of Defence it has concentrated on a certain area of research and has not made its capability available to other civil areas in the way it assuredly would have done if it had not been owned by the Ministry of Defence. That is a national tragedy. We have a tremendous laboratory there which has not been utilised for wealth creation. It has done its job very effectively but it has not been free to develop in the way it naturally would, looking at its own strengths.

Dr Bray

484. Is the distinction between curiosity driven and mission oriented research really very helpful? If you go and talk to the actual scientists in first-class laboratories, like the Laboratory of Molecular Biology in Cambridge, about the scientific basis of their work, do you find that very soon they are talking in hugely ambitious terms about its applications and about its relevance?

(Sir Robin Nicholson) That is absolutely as it should be. I tried to emphasise in my earlier comments that we would not want to disturb the research provider level in any way at all; indeed, we would want to enhance it. What we are saying is at executive funding level there should be a separation between those funding bodies whose role in life is to support curiosity driven research and those whose role in life is to enhance a certain mission and make it possible. But the funding from both those bodies might well go to people side by side at the same bench—indeed, we hope it would. I see this actually as a means of really protecting curiosity driven research. At the moment I think people are often forced into spurious relevance to defend their fundamental research. It ought to be possible for a person to say "This is some extraordinary thing happening here. I don't know what's going on scientifically." It may or may not have any relevance but it is curiosity driven.

485. That is not the way they think. The way they think really is, "What a lot of deadbeat industrialists who have not the wit to see the applications of what they are doing".

(Sir Robin Nicholson) That is a separate issue.

Chairman

486. And quite an important one.

(Sir Robin Nicholson) I think research scientists do think that way. They are often wanting to pursue something simply out of curiosity about what is going on.

Dr Bray

487. That is not the actual reality of the situation. Have you read the ABRC evidence where in paragraph 6 they say, basic research is solely curiosity driven then it becomes strategic the moment a possible relevance, however remote, can be envisaged. Our experience tells us that remarkably little of the work supported by the Science Budget can be defined as 'basic' in this way. On the other hand, we see many examples of research output which underpins our fundamental understanding of biology and physics and which has been stimulated by problems arising from applications elsewhere." It is a very much more complicated network than you are envisaging.

(Sir Robin Nicholson) I agree completely with what is said in the ABRC evidence on that. I think the structure we are proposing will enhance that process.

488. Let us look at this from a mission oriented point of view. Having looked closely at the experience of GEC and Cyril Hilsum's view about the balance between corporate and operating company research, the corporate laboratory versus the operating, there is an emerging view that, if you leave it to the operating companies, if you leave it simply to the customer to formulate a problem, you are just into trivial trouble-shooting, you get no serious work done. You have to have a serious longterm corporate research laboratory. Even within the mission oriented world it does not work to separate out the applied from the more fundamental. How much less does it work across the whole field of science?

(Sir Robin Nicholson) I think you are touching on two different issues. One is what is happening at the level of the research provider; the other is what is happening at the level of the executive funding body. I agree with Dr Hilsum that, if you leave organisations to their own devices and they are strongly profit driven, there is always a tendency for them to concentrate on the short term because you are very familiar with the comment "If we don't win in the short term, the long term does not matter". So that happens. It is the role of the main board of a company to ensure that its research is not systematically downgraded in that way. That is why most companies do have some element of corporate research. Whether that corporate research is done in a corporate research laboratory or as corporate research in a divisional laboratory is another matter entirely. That is the research provider point. But what we are saying is that at the executive funding level it is very important to protect curiosity driven research. that is why we are suggesting a separate council for it.

[Dr Bray *Contd*]

489. Would you be happy for Pilkington's not to own any of the research laboratories?

(Sir Robin Nicholson) I do not think there is any analogy between Pilkington and the Research Councils because Pilkington, like other companies, are there to manufacture, research and sell products; the Research Councils are not there to manufacture, research and sell products.

490. What about mission oriented research?

(Sir Robin Nicholson) We are proceeding with research which could lead to manufacture or solve a problem.

Dr Bray: They are pursuing missions too, for example, technologies which will be applied to products and processes.

Chairman

491. So there will be a market at the end of what they do.

(Sir Robin Nicholson) Oh, of course.

Dr Bray

492. What is the difference between that and the Pilkington position? Why can you not contract out all your research?

(Sir Robin Nicholson) We subcontract work.

493. But you own some laboratories.

(Sir Robin Nicholson) Of course, because we are an integrated operation which is manufacturing and marketing and selling; and research and development, if it means anything at all, has to be integrated with those functions as all the literature on third generation R & D makes clear.

494. Is it not the same?

(Sir Robin Nicholson) No, because the Research Councils are not making widgets.

495. Are you not perhaps mistaking the motivation of scientists? They would like to knock out widgets, if only somebody had the sense to seize the opportunity for the future.

(Sir Robin Nicholson) Many, many scientists are motivated that way. I was myself—I still am. That is why I view as very encouraging the way various companies have grown out of Research Council activities, Celltech and some of the ones that have grown out of the ABRC quite recently. But a research council is not making widgets.

Chairman: Thank you for that exchange. Can we now move on to a rather more mundane subject that of the Higher Education Funding Councils.

Lynne Jones

496. I do not think I am going to; I am so interested in this! If we go down the road of distinction between mission oriented and curiosity driven, how do those engaged in curiosity driven research have an influence on policy direction in the structure that you are proposing?

(Sir Robin Nicholson) Those engaged in curiosity driven research are going to be side by side with those engaged in mission oriented research. I can see people going from one to the other and back again. So the way in which they will influence the overall strategy is by the proposals they can make for either mission oriented or curiosity driven research but they are basically in the position of providers of research and they can make proposals. Funding at the moment quite rightly is reactive funding with people making proposals for where they see gains can be made and where they see advances in science can be made.

497. Is that not influencing what people put forward as proposals?

(Sir Robin Nicholson) Of course.

498. Therefore stifling some of the curiosity that we need?

(Sir Robin Nicholson) I think that is tending to happen at the moment. This is a very judgemental matter but I think that is tending to happen at the moment and I think the emphasis on relevance has been too great and, as I said earlier, I think I come back to people and they will say, "I will couch my research precisely in this way if I am putting it to this body and another way if I am putting it to another body." We think that point needs to be clarified. It is absolutely right that people should be able to put forward a research proposal which says, "I am fascinated by this area of science. I don't understand it and I don't think anybody does. I want to do research and development to understand it better." That is the message and it is good and it should be funded.

499. How does it come back in terms of the balance between the level of funding. For example, do you envisage a preordained division of funding between the two blocks?

(Sir Robin Nicholson) It is an iterative process. I think the pressure for funding of high quality work in what we have called the Council for the Advancement of Scientific Knowledge, and the mission orientated council will be felt by OST. It will feel pressure in one area and feel pressure in another area and it will have to take a very broadly-based view on the allocation of funds in the first instance. It will then feed down through those councils. Again seeing we have quoted Lord Rothschild already one of Lord Rothschild's comments was that there is no answer to the question, "How much fundamental research?"

500. On a slightly different tack why should there be public funding for mission oriented research which has a wealth creating propensity?

(Sir Robin Nicholson) I think there are a number of reasons for that. I think firstly mission oriented research is not only aimed at wealth creation, it is aimed at improving the quality of life that we have and the environment and the responsibility for that is partly the responsibility of government departments.

[Lynne Jones *Contd***]**

501. You distinguished between those two areas at the start, the wealth creation and the quality of life—although I do accept that producing a drug that can make people better improves the quality of life—but you made the distinction so I am drawing on that distinction in the question I ask.

(Sir Robin Nicholson) You are asking about wealth creation as distinct from the quality of life. On wealth creation I think industry is primarily responsible for wealth creation in this and in other countries but one area in which government supplies to industry or provides the funds for the supply to industry is for skilled people, as we have already discussed, and that I think we have already accepted as an appropriate role for public funding. Another area is in the development of generic technologies because these are going to be broadly used by society as a whole—by industry, by government departments and so on. I think a third area which relates to that section is the question of risk.

502. Should not companies buy into that rather than it being funded publicly.

(Sir Robin Nicholson) Yes, we are proposing that funds should be coming from OST, government departments and from the private sector and clearly the proportion of this will depend on the nature of the topic. It will be much more publicly funded in some areas and much more privately funded in others. I think that will emerge naturally from the structure that we propose.

Chairman: I think we will leave the risk of funding although you do have a number of suggestions about dual funding which seem to us to be highly curious but we accept there are obviously difficulties about funding. Let us move on now to the question of advisory bodies. Sir Trevor Skeet?

Sir Trevor Skeet

503. Sir Robin, I notice you are going to set up a National Advisory Council on Science and Technology, NACOST. How does that body differ from your organisation?

(Sir Robin Nicholson) I think we would see it as a continuing evolution of what has been happening over the past five years which we discussed earlier in this evidence. I think there has been a feeling, which I certainly support, where ACARD and ACOST in its early days did too many very specific pieces of work aimed at things like bio-technology and advanced materials and not enough at a strategic level. I think what we are proposing in NACOST is virtually total concentration on strategic advice. I think the second criticism that has been made which again has been to some extent met with the current structure of ACOST, is more of the actual work should be commissioned from outside bodies. So NACOST in the future should develop strategic advice based on this outside work. As you will be aware from our report on the science base the whole of the factual material for that was developed by SEPSU, Royal Society of Engineering. We see it as an evolution from ACARD to ACOST. We do feel whatever the structure the government finally decides on there is a proven need for independent advice at a strategic level. Different countries do it in different ways. We have looked at the PCAST system in the United States for example, but I think the precise details cannot be decided until the government has decided what structure it wants within government because the advisory structure, of course, has to serve government.

504. Yes, but, Sir Robin, as soon as ACOST has come into existence a new Ministry has been formed.

(Sir Robin Nicholson) Yes.

505. Is it not for them to decide strategic considerations and if they wanted advice why could they not go to the Royal Society which has got a widespread base of very very distinguished men. Why can they not go to the Royal Academy of Engineering for advice as well. Perhaps they will be serving up enriched advice of better or of the same quality that you are producing. Why do we want to have these other bodies brought into existence?

(Sir Robin Nicholson) I think the first point to make, of course, is that most members of ACOST are Fellows of the Royal Society or Fellows of the Royal Academy of Engineering.

506. Exactly.

(Sir Robin Nicholson) Much the same people may be involved—I totally accept your point that as soon as ACOST was set up OST has changed the situation. I think OST will have available to it much better and more comprehensive advice than has ever existed in the centre of government before. That is one of the reasons we are proposing a reduced role for ACOST at a specific level. There is nothing at all to stop the Royal Society or Royal Academy of Engineering offering advice to the government of the time. They do this of course. The only question really is whether the government wants to appoint an independent advisory structure which is free from any vested interests and whether it believes it will get additional advice that way which it would not get from other bodies. I think that the history around the world suggests that does happen and that if you rely solely on other organisations for advice you very rarely get advice which does not have some vested interest in it.

507. I think you will agree with me, finally, that a multiplicity of organisations does not necessarily enrich science or technology?

(Sir Robin Nicholson) A multiplicity of advisory organisations?

508. Yes.

(Sir Robin Nicholson) I think the structure we have at the moment is really very simple. I think there are departmental advisory structures like ABRC, like ACARD, like the defence advisory body, the priorities Board of MAFF which are advising departments and ABRC advises the centre of government as a whole. That I think is a simple structure.

[Sir Trevor Skeet *Contd*]

509. Was it not made more simple recently by forming a Ministry put on top largely taking over the responsibilities or part of the responsibilities that are handed to you?

(Sir Robin Nicholson) I agree with that. That is why we are suggesting a broader, more strategic role for ACOST. You could abolish ACOST altogether, but I think the practice round the world and in this country is that government is ill-advised not to have a body from which it can get independent advice when it wishes.

Chairman: Let us now turn to an institution which also provides advice, namely, the Chief Scientific Adviser.

Mr Williams

510. Sir Robin, in your submission you suggest a much more interventionist or more powerful status for him in the Public Expenditure Round. You say that the Chief Scientific Adviser should be involved in departmental discussion at an early stage and have a much more interventionist and directive kind of role. Is that a fair summary? Should the CSA be a much more powerful office?

(Sir Robin Nicholson) I think I would make two points on that. The first is regarding the CSA within OST and the second is as to the CSA with regard to other departments. You raised both those. As far as the CSA within the OST is concerned I think it would be a mistake if the CSA became too involved in the management of the funding which is going through OST. I do not see how he can—and Rothschild said this—at one time be the chief scientist in a department responsible for the funding, accountable for the funding, and at the same time be an adviser when he is looking much more broadly. I think that the CSA within the OST should not have a major role in the line management, in the accounting officer chain. As far as other departments are concerned, I think the way ACOST saw the role of the CSA is very much like the role of the director of technology in a large company with many divisions, each of which has its own technical director. He is there to look across the board and to take a second view about the wisdom of what a department is doing. I think we have seen an example in the last few years where the departments have been unable to respond to the requirements of their ministers because they had inadequate knowledge of the science and technology which lay behind some of the policy issues which ministers were facing. For example, in the Department of the Environment I believe this to have been the case. I think one of the roles the Chief Scientific Adviser has is to look at the policy and other issues which are facing a minister, to look at the science and technology which he has at his disposal, to inform him on those issues and to take an independent view as to whether the department is carrying out sufficient research and development to enhance the quality of that science and technology to meet the minister's wishes. It is an overview, if you like, from the centre as to the specific missions and the science and technology available to different departments. We think it should come at an early stage in the PES process so that it can be an important part.

Chairman

511. Let us probe that a little bit. In answer to the question you used the word "overview". There is an opportunity, is there not, (a) in the structure which OST themselves are proposing and (b) in the role of adviser, to come closer towards a directional science policy. Now, is that something you would welcome?

(Sir Robin Nicholson) No, Chairman, we would not. We did look very carefully at a ministry of research and technology German style, which I think is broadly what you are pointing at. I think the danger of a ministry of research and technology German style is that ministers who are accountable for policy, health, environment, transport and so on no longer have the control over their own science and technology which is there to inform their policy. They are in the hands of another department and so, if their policy is found wanting because there is inadequate science and technology back-up, they simply say "Don't blame me, blame OST and blame the ministry of research and technology". What happens in Germany in the whole ministry of research and technology is that they have lost control of their science and technology for policy purposes, so they start up a second lot of science and technology. I think that is a bad system, although it has attractions from a coherence and strategic point of view. We believe in ACOST that science and technology is fundamentally there to serve other purposes, it is not primarily an end in itself. If it is to serve other purposes, then ministers of the Crown have to be able to commission their own research and development and improve the science and technology base of their department.

Mr Williams

512. One question on the proposed discussions between the departments and the scientific adviser, should the departments themselves be prevented from diverting money that is earmarked for research? I had in mind the Health Service at this moment in time. With changes to trust status there is a threat there to research carried out in hospitals. Should the Chief Scientist have a role in safeguarding the research work carried out in the NHS and in that way across the departments?

(Sir Robin Nicholson) I think where there is a transfer of funds in either direction—it would be fair to say at the start of the BSE problem I suspect funds were transferred into science and technology in certain departments—that should be a subject for review and discussion between the Chief Scientific Adviser and the department concerned in the subsequent year. I think you run into the same problem as I have been outlining for a ministry of research and technology if the Chief Scientific

[**Mr Williams** *Contd*]

Adviser has a power of veto on transfer of funds, but he should have power to investigate that and comment on it when the next PES round occurs.

Mr Batiste

513. I was very interested in your answer on the German style ministry of science and technology because a certain amount of the evidence we have had has suggested that was a more effective move forward. Is having a Chief Scientific Officer in a semi-freestanding department like OST actually a happy compromise between having him in the Cabinet Office and having a German style ministry, or is that the worst of both worlds?

(Sir Robin Nicholson) I think it is quite an ingenious compromise actually. I was always undecided about the merits of bringing science into the centre of government in the way that has been done, and I think the two things which have convinced me that this is the right way to go now are these: firstly (and we have not actually touched on this area at all) the enormous advantage it gives us in the European Community. When I was Chief Scientific Adviser to the Cabinet Office I went to the Research Council with more than a dozen ministers and we were patently at a disadvantage to other countries because we had different ministers handling different issues in the Research Council. That is point one. Secondly, I think the status of the whole department has been enhanced by OST being part of OPSS and, therefore, instead of being a small rather peripheral area of Cabinet activities, it is a major department under one of the major non-governmental ministers. I think this has therefore enhanced the role of the Chief Scientific Adviser, to be working for the Chancellor of the Duchy in his department. I think those two things, the Europe issue and the rather felicitous combination of the other activities in OPSS, have in my view tilted the balance. I feel the present arrangement is good.

Mr Miller

514. Leading on from that, in this area of relationships between the departments and OST, one imagines all sorts of frictions emerging and practical log-jams. In a very practical sense, by what means can OST ensure that other departments' research spending plays a part in national research and development? How is it working in practice?

(Sir Robin Nicholson) I think this is one of the benefits of the proposals which we have made. Our programme directorates are designed to receive funding from OST, from government departments and from the private sector, to tackle particular problems and I think then that provides a structure which will intrinsically work for the national interest. I return to the example I gave earlier of food safety where there is a congruence of requirements by OST in its role in the science base, by several government departments and by the private sector. So I think that is the way that the national need will be met.

515. This would be a coordinating function?

(Sir Robin Nicholson) It would be a coordinating function.

516. So presumably on food safety there would be several departments involved, the DTI and Health and so on?

(Sir Robin Nicholson) It has a coordinating function with teeth—perhaps an unfortunate choice of words when we are talking about food safety—because the OST would have substantial funds to direct. Obviously, as you will have gathered, I am very enthusiastic about this aspect of our proposals because it does seem to me to have a nice self-balancing aspect. OST can see the government department is putting a lot of money into food safety—Unilever and Sainsbury's want to put a lot of money into it—and we want to put some money in to ensure the research base is well underpinned. Equally it can use its research foresight capacity. We believe that it is going to make a profit, therefore we will put in lead funds in the hope other people will follow. It seems to me to be very very flexible and be a structure which is intrinsically supportive of collaborative research. At the moment we have structures non-intrinsically supportive of collaborative research and then we dream up all sorts of schemes to have people collaborate. It seems to be a cock-eyed way of doing it. If you believe the research is a good thing it does seem better to have a structure that encourages it rather than a structure that discourages it and then finds ways of getting round the structure.

You referred then to research foresight activities. A last question. Mrs Campbell?

Mrs Campbell

517. I can see that in order to assist in the identification of trans-departmental issues you do need some sort of overall strategy and you have referred to these "research foresight activities". Is this not close to "picking winners"?

(Sir Robin Nicholson) No, I think it is scenario painting.

518. Is it possible to amplify that in a few short sentences?

(Sir Robin Nicholson) Possible but unwise, I suspect! If you will permit me 30 seconds. I think there is a role for OST in scenario painting. I think the question of picking winners within the various scenarios is very much the job of industry.

Chairman: I am very glad to hear you say that, Sir Robin. Thank you very much. You have been here for just an hour and you have covered a lot of ground. I am most grateful to you. I also compliment you that you have your advisers either side and never used them once. That shows a man who knows his stuff!

Letter to the Clerk of the Committee from Dr John McGuinness, Head of the ACOST Secretariat (24 November 1992)

Thank you for your letter of 19 November seeking clarification of the ACOST advise in relation to the Higher Education Funding Councils.

Your first question is about the advantages of the proposed transfer of funds for research to OST from the DFE and the territorial departments responsible for education in Scotland, Wales and Northern Ireland.

The present structure provides two sources of funds for research in universities. First, research funding is provided through OST (as part of OPSS) to the Research Councils where it is allocated on a proposals basis. Second, funding is provided through separate Departments in England, Scotland, Wales and Northern Ireland to HEFCs to be allocated for the baseline funding of research.

The HEFCs are adopting an increasingly selective approach to the funding of university research and there is an increasing emphasis in the Research Councils on ensuring the greatest benefit from the funds provided to universities. There is a need to ensure that the impact of these systems is properly understood and that they are well aligned to national policies and objectives.

ACOST proposes that OST should develop a strategy for science and technology in the UK which would encompass all publicity funded research. The extent to which the funding programmes of the Research Councils and the HEFCs were aligned to such a strategy might therefore best be considered by OST taking a central overview of the whole process rather than splitting this responsibility between several different departments. This would allow OST to consider the impact of the HEFCs' funding algorithms and whether any changes in policy might be required as well as the balance of funding between the HEFCs and the Research Councils.

ACOST supports the continuation of the dual funding system but proposes that the provision of baseline support for research in universities by OST through the relevant HEFCs would lead to a more coherent approach.

There is, in addition, an argument for increasing efficiency in the collection of data on research carried out in universities and for the use of common databases in developing an understanding of where research funds might most usefully be spent.

The second question concerns the bidding by the HEFCs in competition with CASK and CMOR dor OST funds.

The form of words used in the advice reflects the fact that under ACOSTS's proposed structure, OST (OPSS) would bid for funds to Treasury at the time of the PES round and that decisions would be made through discussions between OPSS and Treasury. The respective claims for funds of CASK, CMOR and the funding Councils would inevitably have to be considered by OPSS on the basis of the submissions made by the various Councils and on the strength of the case they put forward.

The general thrust of ACOST's advice has been to create the greatest possible coherence in the structure for S&T in the UK and the greatest possible alignment of S&T with national priorities and goals. The proposals for the HEFCs are one aspect of this broader approach.

If the Select Committee wishes to clarify any further areas of ACOST's advice, please do not hesitate to contact me.

Memorandum submitted by the Advisory Board for the Research Councils (22 September 1992)

ABRC: TERMS OF REFERENCE AND MEMBERSHIP

TERMS OF REFERENCE

1. To advise the Chancellor of the Duchy of Lancaster on his responsibilities for civil science—with particular reference to the Research Council system and its articulation with higher education, and the proper balance between national and international scientific activity.

2. To advise the Chancellor of the Duchy of Lancaster on the resource needs of the Research Councils, Royal Society and Royal Academy of Engineering, and on the allocation of the Science Budget between these bodies.

3. To promote effective collaboration between the Research Councils and the harmonisation of their activities, and to advise the Chancellor of the Duchy of Lancaster on any necessary transfers of responsibilities between Councils.

4. To work closely with the Higher Education Funding Councils on issues concerning the support of research in higher education institutions, and the training and support of postgraduate students.

5. To promote effective collaboration between Government Departments and Research Councils in the development of both their forward strategies, and in arrangemments for commissioned research.

6. To promote productive interaction between the Research Councils and the users of the research which they support.

MEMBERSHIP

Sir David Phillips KBE FRS	Chairman.
Professor Sir Eric Ash CBE FRS FEng	Rector, Imperial College London.
Professor T L Blundell FRS	Director General, Agricultural and Food Research Councils.
Professor D A Currie	Professor of Economics, London Business School.
Dr A Ganguly	Director, Research and Engineering, Unilever plc.
Professor R L Gardner FRS	Director ICRF Developmental Biology Unit, University of Oxford.
Professor M Hart FRS	Professor of Physics, University of Manchester.
Professor J L Knill FEng	Chairman, Natural Environment Research Council.
Professor H J Newby	Chairman, Economic and Social Research Council.
Dr D A Rees FRS	Secretary, Medical Research Council.
Sir Mark Richmond ScD FRS	Chairman, Science and Engineering Research Council.
Professor I A Shanks FRS	Chief Scientist, Thorn EMI plc.
Professor W D P Stewart DSc FRSE FRS[1]	Chief Scientific Adviser, Cabinet Office.
Mr R Dawe[1]	Deputy Secretary, Department for Education.
Dr D G Libby	Secretary.

July 1992

[1] Assessors.

Examination of Witnesses

SIR DAVID PHILLIPS, KBE, FRS, Chairman and DR D G LIBBY, Secretary, Advisory Board for the Research Councils, were examined.

Chairman

519. Good morning, Sir David, and welcome. It is very good of you to come here and offer to give oral evidence to the Committee. As you will know, we did ask the Chancellor whether we might have sight of the recommendations which you and your committee had made to him and this he kindly has done but I have to tell you that it arrived fairly late, in other words the day before yesterday so the Committee is not perhaps as fully sighted as it would be about the nature of your proposals although we have, I think, one or two fundamental questions which have arisen out of the proposals. However perhaps initially and bearing in mind the relatively short time that we have, if you could make a brief summary of your statement and what you put to the Committee we would be very pleased to receive it.

(Sir David Phillips) Thank you very much, Chairman. I have very little to say by way of introduction. I should further begin by saying that I am, of course, a member of ACOST so that to some

[**Chairman** *Contd*]

extent I am associated with the philosophy and the proposals that Sir Robin has been outlining to you but I do have to say that I differ somewhat sharply from him, as you can see in the paper, on a number of issues particularly about the rather sharp distinction that he would like to make between funders and providers of research and, secondly, on the usefulness of making a sharp distinction between curiosity driven research and the rest.

520. I think we are aware that there is an element of disagreement but as in all scientific exchanges it will be kept at the colloquial level. Could you introduce your colleague on your right.

(Sir David Phillips) He is Dr D G Libby, Secretary of the ABRC.

521. I have several questions. What is OST for?

(Sir David Phillips) In my view it is to provide a central focus for science and technology within government, which is important for the sort of reasons that Sir Robin was outlining. I think the presence of a Minister responsible for the government's principal directed expenditure on science and technology is important. I believe that having a Cabinet minister involved in European affairs is important and I believe that having a Cabinet minister of the Office of Science and Technology watching over the overall government expenditure on science and technology is also important. I could go on to say that within the OST there is direct responsibility for the science budget and that it is really the only departmental budget which is solely devoted to science and technology and within which therefore priorities can be set on scientific and technological grounds. The government departments also spend more, I should say, on science and technology but they do not have science and technology budgets in general. They have to balance the importance of science and technology against the other matters for which they are responsible. The Ministry of Defence, for example, has to wonder how much money it should spend on science and technology as compared with how many additional soldiers it may want to support and so on. It is right then that there should be the OST and the Chief Scientific Adviser to oversee how the balance of these other government department's decisions turns out and making sure that overall they work out to the national advantage and if they do not that something could be done about it.

522. Now you have, Sir David, recommended that there be changes in some of the advisory structures and indeed you have suggested there should be something known as the "Board for the Research Councils". How in effect would this differ from ABRC and your own role?

(Sir David Phillips) Not a great deal as I see it and here you see the interesting parallel between the ACOST and ABRC advice that each comes up in effect with a continuation of itself. The Board for the Research Councils leaves out the word "Advisory" and that perhaps reflected the debate that went on within the Board as to whether the Board for the Research Councils should become a more executive body—perhaps even the board of a single research council—or whether it should remain advisory. In the outcome the advice says that the Board should remain advisory and we might perhaps have been wiser to call it the "Advisory Board for the Research Councils".

523. Between the lines there seems to be a tone of perhaps central strategy directional thinking trying to get the science base, as it were, more formal and more strictly controlled by central government.

(Sir David Phillips) I think the trend over the years in which I have been the chairman of ABRC has been towards bringing research councils rather more closely together to understand their different objectives and to take advantage, if you like, of the best practice of each. So the Advisory Board for the Research Councils has progressively stiffened up its view of research councils' objectives and the priorities set both within and between the research councils. That seems to us a necessary function that would have to continue. There needs to be somebody who can look at priorities across research councils and decide whether increased expenditure on the human genome, say, is more or less in the national scientific interest than increased expenditure on material science and the various other things which would go into the bidding for priorities.

Sir Trevor Skeet

524. Sir David, why cannot OST in fact do what you are doing now in the allocation of money to the Research Councils? After all, the CSA represents everybody at the expenditure round. They will know what it is they will negotiate. If they do so, why have two bodies which we think are dealing with roughly the same area?

(Sir David Phillips) As far as the science budget is concerned, I do believe that having an external independent committee is a very important consideration. Rather difficult decisions need to be made and the scientific and technological reasons for which they are made do need to be set out absolutely clearly. At the end of the day ministers have to decide whether or not they are going to accept that advice, but the formulation of that advice, in my view, ought to be made outside the remit of ministers and their civil servants. If civil servants were themselves proffering the advice, in the end a minister questioned by your good selves in Parliament would have to say "I decided that I would close that institute or cut down that piece of research", and then you would all ask what were the scientific and technological reasons for that.

525. But you are fed by five Research Councils, the most important of which is SERC——

(Sir David Phillips) The largest of which.

526. —- and they are the heavy spenders, but they make an allocation themselves in their own configuration as to the way they want the money to be spent. It comes up to you. Why have two steps?

[Sir Trevor Skeet *Contd*]

You have the major body now which is a ministry with all its civil servants, with all its experts, and on top of that you have the ABRC. Surely this would be enough, would it not? I cannot see any reason for the duplication of authorities.

(Sir David Phillips) I do not myself see that there is a duplication of authorities. Let me explain to you how the budgetary process is now run with the Research Councils. The Research Councils, of course, have their real budgets for the coming financial year and their planning figures for the two years after that and the ABRC sees it as the responsibility of each Research Council to fund those scientific and technological topics which they regard as being of the highest priority from their baseline funding. Now, they always have other things which they regard as important to do which they cannot fund from their baseline funding, so they make bids during the public expenditure round for additional funds for these additional activities. By definition these additional activities must be of lower priority than those that they are funding within the baseline, that is, within a particular research council. When it comes to the ABRC, the ABRC has to wonder whether the bids that are being made by one Research Council are more or less important than the bids being made by another Research Council and progressively whether the bids made by one Research Council are of greater or lower priority than the baseline funding of some other Research Council. So it is a rather complicated issue in which Research Councils have progressively, I believe, learned to play the game in a reasonably straightforward manner and where the ABRC has imposed, I think, a rather stringent and effective discipline. Now, in effect, that could be done, if you like, by OST insisting on a similar process, which I am sure they would. But then who would make the judgment about whether, as I have said, an increase in funding for molecular biology is more or less important than an increase in funding for material science, civil servants or independent scientific advisers? I believe the latter is extremely important, given that at the end a minister would have to make a decision about it.

Chairman: I think we move at this point to something pretty fundamental in your own report.

Dr Bray

527. Sir David, in the ABRC document you set different possible subdivisions of science, by discipline, by the nature of activity or by mission. In the present pattern of research councils there is some accommodation of each of those. The ACOST evidence comes down heavily in favour of dividing by nature of activity; you question that and you put forward the establishment of entirely mission oriented research councils. That is a pretty radical departure from the present pattern, is it not?

(Sir David Phillips) I do not know that it is as radical as it seems. In my view, some of the most successful Research Council activities have been carried on by councils which do regard themselves, and always have regarded themselves, as mission oriented research councils—the Medical Research Council, the Agriculture and Food Research Council, the Natural Environment Research Council regard themselves as mission oriented councils. The SERC which has already been mentioned began by regarding itself as a council that was there to support research generally in higher education but over the years it has become a council with a sort of unwritten mission to support United Kingdom industry and wealth creation. We think it would be better to recognise that.

528. There is still within the mission oriented case of the MRC the fact that they have only recently established this concordat with the NHS, the NHS only recently setting up its own research activity.

(Sir David Phillips) I do not think that affects the argument, Dr Bray. They were always mission oriented, they were founded in 1913 with the mission of helping to deal with the tuberculosis problem; the mission has remained that sort of thing ever since.

529. Nevertheless, in terms of the actual way the working scientist looks at it, they do not, looking at the pattern of research councils, now see them as discipline oriented or mission oriented; they seem the as just sources of funds for what they want to do and they get on with it.

(Sir David Phillips) I am afraid I do not agree with you. I think the scientists who turn to the MRC and see the MRC as a mission oriented council which wishes to exploit the research work for the benefit of the nation's health. The scientific community largely sees the SERC as being divided into a number of disciplines and that again, I think, is one of the problems with it. The SERC, because it is or has been very strongly discipline, oriented and organised on a disciplined basis, has found it relatively difficult to organise work which is interdisciplinary or runs across disciplines.

530. Is the statement then in your document, that the establishment of mission oriented councils helps to bring about a culture change, merely a sort of presentational rearguard action against the barbarian hordes from ACOST wanting to drag you up on to a mission oriented basis?

(Sir David Phillips) I think we actually came to the mission oriented council view independently of ACOST. I should explain I was not a member of the ACOST sub-committee that drafted the report.

531. Can we pursue your formulation of that then in the particular missions which you set out in Annex A of your document? They are for biology and the biosphere, the geosphere, astronomy, physical and engineering sciences, medical, social sciences and humanities. That increases the total number of research councils by one. It brings humanities into the field. It divides up the activities of a number of them. That is quite a major reorganisation.

(Sir David Phillips) Yes.

532. It is formulated on the principle of getting them mission oriented?

[**Dr Bray** *Contd*]

(Sir David Phillips) Partly that, partly also to bring together coherent activities in a better way within different research councils so as to make them more efficient and effective.

533. Well the Biology and Biosphere Research Council appears on the face of it to be a combination of the discipline of biology and the mission in the biosphere.

(Sir David Phillips) I do not want to get into a semantics discussion particularly, Dr Bray. It amounts to an enlargement of the Agriculture and Food Research Council by taking over the biology responsibilities from the SERC and some part of the biological activities of the Natural Environment Research Council, which in our view have been the relatively poor relation within the NERC creating in a more effective biology and biosphere organisation the role of which would be very much to underpin the development of the burgeoning biology-based industries which many people think represent the future of large industry in this country.

534. Would the ultimate objective of "the better employment of biological resources in support of economic competitiveness and the effective and efficient management of the natural and man-modified biological environment to enhance the quality of human life," would that give a coherence and momentum and public face to the combination of different activities brought in from NERC, FERC and SERC? What would the mission add to the combination of activities?

(Sir David Phillips) I think it would make it perfectly clear to the organisations concerned what they are about. I think there is confusion in the scientific community which has grown up post the Second World War very much on the hypothesis promulgated by Vannevar, Bush and others that provided that one has a healthy science base then the economy will automatically be healthy. I do not think anybody could any longer sustain that view. At most they would say a healthy science base is a necessary but not sufficient condition for supporting a healthy economy. Some would not even go that far. I think scientists in general need to recognise that being good at science of itself is not enough. They should be concerned also about the application of their science.

535. The Geosphere Research Council is well-defined. Is there a question about does biology not impinge on geosphere pretty substantially?

(Sir David Phillips) It does and the NERC, and others in the community who would disagree with me, will probably. However, there is major activity in earth sciences and oceanography which really needs to be enhanced by the importation of experience particularly in earth observation from the SERC and, as I have said, there is work in the old NERC that relates more closely to the work of the present AFRC and would be better united with that.

536. Astronomy and particle and nuclear physics would bring together big science activities and it would allow areas of a similar nature to be compared with each other and it would allow the community at large to judge what priority it wanted to attach to this field. That is in a way "big" science being up front and saying effectively to the politicians, "Do you want to fund this or not?"

(Sir David Phillips) It would in the end have that effect. I think these areas come together from a scientific point of view fairly satisfactorily. You could call it a Cosmology Research Council if you like. It does at the moment very much dominate the thinking of SERC having within it this incubus if you like of very large expenditures which are governed in part by international treaty. We think it would be better to bring these elements out into a separate organisation while retaining them within the research council system so they can first of all be judged against other scientific activities across the research councils. They would then be identified by the politicians and those political and diplomatic considerations that are involved in the funding could be considered.

Chairman

537. Sir David, could I at this point just go back to the beginning of this exchange. Is there here a significant difference of principle being applied to the organisation of scientific research, whatever the discipline, or is this merely a restatement of, as it were, the case today because it has moved in that direction. That is question one. Question two is there in consequence a significant difference or not between what you are proposing and what ACOST are proposing?

(Sir David Phillips) On the first issue what we are talking about here is a readjustment of the boundaries of the research councils to catch up with the evolution of science and the way in which emphasis now has to be put on different subjects.

538. You are just saying, "We are looking towards the year 2000 and beyond we think the organisational structure of science in research should be of this character."?

(Sir David Phillips) Exactly, Chairman. Is there a difference between us and ACOST? Definitely so. We do not believe that curiosity driven research should be separately funded. As we say in the paper we believe each mission orientated research council should be prepared to support that science which it regards as important for the fulfilment of its mission and that would include developing those areas of fundamental science which in its far sighted way a research council could see was going to affect the achievement of its mission, as, for example, the Medical Research Council did through the development of molecular biology from 1947 onwards.

Dr Bray

539. Whatever way the best practice is presented as to the extent of the mission orientations and so on, I would have thought it would be clearly helpful

[**Dr Bray** *Contd*]

to the Chancellor of the Duchy of Lancaster and also I think probably helpful to this Committee in the view that we present to Parliament if we were able to say that in the future this mission orientation of the research councils had the clear support of the science community as a whole.

(Sir David Phillips) I think one of the advantages, Chairman, of your Committee prompting the relatively early publication of these reports is that the scientific community will undoubtedly now engage in a debate on the issue. It is from that debate I hope will come the acceptance of some of the arguments at least that we are putting forward.

540. A paragraph in your evidence that notes some of the issues that a debate would cover, (paragraph 31) says "Any reorganization of the present Research council system would require detailed work to enable the consequential restructuring of board and committee responsibilities and the reorganisation of institutes and facilities. It should therefore be expected that a cost-benefit analysis would be carried out——" That detailed work has not been done. Have you any idea how long it would take?

(Sir David Phillips) I would hope that if the Chancellor agreed that it was worthwhile doing that because the recommendations were likely to be implemented, that the ABRC with the research councils concerned could accomplish that over the next three months or so.

Chairman

541. Your point there and indeed your evidence, which was designed for White Paper assessment and possible publication, is that you regard this as an exercise which could be concluded if the White paper accepted this is the direction in which they wanted to move?

(Sir David Phillips) Yes.

Dr Bray

542. You talked about each of the research councils having an interest in manpower questions. You put forward proposals for professional development and so on. That would be some departure from the present practice by which the SERC in fact provides the bulk of the training of post graduate students?

(Sir David Phillips) Yes, the SERC itself at the moment provides the bulk of post graduate training. This is a subject which the ABRC in collaboration with the research councils—because I should emphasise that heads of research councils are full members of the ABRC and play a full part in all its discussions—the ABRC has been extremely concerned about the manpower issues over the last few years and has an extremely active manpower sub-committee which is chaired by Professor Howard Newby, the Chairman of the Economic and Social Research Council, and has produced a good deal of interesting information. We shall be pursuing very hard, for example, the various reasons for which graduate students are supported by the different Research Councils, why they support them in different numbers, why they support them in different numbers in different subjects, and so on.

543. Finally, you say consideration should be given to enlarging the scope of the Board, that is, the Advisory Board for Research, to reflect the wider responsibilities of OST as they develop. Would that Board for Research play some role in looking at research commissioned by other government departments?

(Sir David Phillips) Well, we already do that, Dr Bray, in that it is naturally a part of our forward look exercise to consider with those Research Councils which do commissioned research for government departments how that commissioned research is affecting their overall portfolio, and we also have regular meetings with the chief scientists of government departments and discuss their plans with them and the extent to which they are likely to be commissioning research in the future. So we already do that and I would expect we would have to continue to do that. I think we had in mind there also the problem—not the problem, the question—of the research funded through the Higher Education Funding Councils and the way in which responsibility is at the moment separated between research councils and funding councils.

544. Would the Chairman of the Research Board in some future situation possibly develop into the Chief Scientific Adviser?

(Sir David Phillips) No, I do not think so. I think that is a separate, distinguishable role not to be confused with this chairmanship.

Chairman: You mentioned higher education. Lynne Jones.

Lynne Jones

545. I would like to explore the relationship between the Higher Education Funding Councils and this board you propose. Why should they not have representatives permanently on the board? I am afraid I am dotting about my brief, which I have not read properly—please excuse me. On this business about transferring firm funding for that element of academic salaries engaged in research, could you comment?

(Sir David Phillips) As to the first question, if you have a look at paragraph 73 you will see that the proposed membership of the board includes a representative of the funding councils. One of our problems is that there are now three, if not four, funding councils, if you include the Northern Ireland Council, and we thought that that would be too dominant an influence on the board for the research councils if we included representatives of all of them. We would be very happy, indeed would like, to have a representative of all the funding councils, but a single representative, and then involve the other national funding councils when the business required that. Going beyond that, I should say that already we are taking some pains to ensure

[Lynne Jones *Contd*]

that we are fully aware of what goes on in the Higher Education Funding Council world. I am a member of the Higher Education Funding Council for England; I am an observer on the Welsh Higher Education Funding Council. We have held a meeting in Scotland with the Chairman and Chief Executive of the Scottish Higher Education Funding Council and we are in January holding a meeting in Cardiff with the Welsh Higher Education Funding Council. So we do work very hard at the ABRC level and also at the research council level to keep tuned in with the Higher Education Funding Councils. Again I have no doubt that would continue.

546. What do they feel about this proposal then to transfer that element of academic——

(Sir David Phillips) I am sure they do not like it at all and will resist it to the death. The problem is —well, there are a number of aspects to it. The first is at the moment, if different agencies are competing for grants or contracts, if you look at it superficially it looks as though higher education contracts are cheaper than contracts, say in research council institutes or in government research institutes or agencies, and that is because of the block grant to higher education coming from the funding councils which pays a percentage of academic salaries and for the costs of academic premises. That leads to a non-level playing field. So in the first instance we think that in applying for grants and contracts, so that we actually know what the full costs are and so that academics themselves know what the full costs are, they should give us a clear indication of what additional costs arise that are being paid for from the block grant as salaries and premises expenses. Going beyond that, we think that it is desirable in the longer term that the part of the block grant (and this would not be all of the block grant) which pays for salaries and premises used in association with research council grants should be transferred to the research council system. Now, why do we think that? Partly because we are concerned with all the pressures on the university system, that they should remain capable of carrying out a large proportion of the nation's research. The research council system already spends 70 per cent of its funds in support of higher education research. That means we depend heavily on the research premises in universities, for example. We would wish to see them properly maintained so that we can continue to exploit them. We think that would be best ensured if we were ourselves responsible for that.

547. I can understand the point about clear accounting in terms of what the money is spent on, but I do not really understand how in practical terms your proposal would actually work because you have the same individuals engaged with part of their work in research, part in teaching and part in administration. How in practical terms do those individuals relate to these divisions?

(Sir David Phillips) The higher education staff putting in grant applications would also put in applications for the use of the premises that were going to be deployed in this work and for their own salaries.

Chairman: Can we move on to advisory structure? Alan Williams.

Mr Williams

548. You suggest in your document that there should be a new advisory body called the Science and Technology Advisory Committee that would advise, through the Chancellor of the Duchy, the Prime Minister and there should be eight members, four from academia, four industrialists on this body. How would that differ from the present ACOST?

(Sir David Phillips) I am not sure that we divided it four and four, but you may be right. This would be a higher level committee, a less bureaucratic committee. The analogy is with the United States President's Scientific Advisory Committee, which is a high level committee which advises the President directly on whether there are gaps in public support of science, and what are the areas of public intervention in science and technology which are important to fill. We believe that a high level independent committee able to spend time on these problems, able to take advantage of a network of contacts, able if necessary, for example, to consult with departmental advisory committees which ACOST does not do, would be well placed to produce general advice to the Prime Minister which could then be looked at in more detail under the aegis of the Chief Scientific Adviser and OST.

549. In that advisory committee should there not be room for consumer representatives, environmental organisations trade unions and could I suggest instead of having half and half industrialist/academia it could be composed of one-third, one-third and one-third with these other interest groups.

(Sir David Phillips) I do not think, Mr Williams, we went as far as saying it should be 50/50 industry and academia. That is for consideration. I think it is also for consideration whether representatives of say consumer interest groups or environmental lobbies, if we can call them that, should be actual members of this group or part of the network with which this group would integrate. I would be somewhat in favour of the latter but that is for debate.

Sir Trevor Skeet

550. When you suggested a moment ago that this body would be less bureaucratic was the inference of your remark that you regard ACOST as being a bureaucratic institution?

(Sir David Phillips) In the past, as Sir Robin has just been saying, it did engage in quite a lot of detailed work which Sir Robin would now consider not the best way for ACOST to perform. I agree with that.

Sir Trevor Skeet: You agree with that. Thank you very much.

Cheryl Gillan

551. I was chafing to get in there when you mentioned the US and their advisory approach because one of the things you said in your introductions was how you welcome the opportunity to have a minister of Cabinet rank going into Europe on our behalf and therefore evening up the position of Europe because the UK has always been in a second-best position. In your paper you suggest that a new type of clearing house is set up to improve communications between the UK research organisations and corresponding research funding organisations within Europe. I was very heartened to see that in there. I wonder if you would take a couple of minutes to expand upon that because obviously our collaboration in Europe is not quite as successful as we would wish it to be.

(Sir David Phillips) Thank you, Mrs Gillan. Part of the drive is that none of us feels entirely happy with the Community programmes and the way in which they are judged and administered. We feel a little unhappy that in a sense the Community has come to occupy not only the centre of the stage but almost the whole of the European stage for science and technology whereas there are, of course, in other European countries organisations parallel to our research councils with whom the research councils have close contacts and with whom from time to time they collaborate. We think that these informal bi-lateral and multi-lateral contacts with other countries ought to be built up; that we ought to be wondering whether we should necessarily keep up a strong hand in some parts of science that some other European country is manifestly stronger in and conversely whether we should concentrate on some areas that we are strong in and the other countries are not so strong in. So we think there is scope for much greater multi-lateral cooperation across Europe rather than trying to do everything through the Community.

Sir Trevor Skeet

552. The question of departmental advisory groups and structures. I understand that the funding reaches them in due course but as a consequence of the coordinisation of the operation. To give you an example: the DTI and the Department of Health. What degree of coordinisation do you see could be accommodated between these two great Departments? They appear to me to be autonomous and they appear to be outside OST. The could be a battle ground generally. Do you see it in that light?

(Sir David Phillips) Well, I agree with the comments that were made earlier that necessarily all these departments have interests in science and technology and need to support science and technology to meet their policy concerns and perhaps for other reasons but they do not in general have science and technology line items in their budgets. People making proposals for science and technology expenditure have to make them in competition with people making proposals for expenditure on other matters within the department concerned. So it is rather difficult to see OST having a central role in allocating science and technology expenditure in these departments and taking an overall view. That is why we suggest that the Chief Scientific Adviser should have a rather stronger coordinating committee involving the chief scientist and/or the senior civil servant from these departments that are concerned with science and technology expenditures. The CSA should I believe take account of that in formulating his view in the OST of what the overall government expenditure should be and how good or appropriate it is. There are other issues between Departments like the DTI and the Department of Health of course. The Department of Health, as I understand it, is the parent department for the pharmaceutical industry. The DTI therefore in my view pays rather too little attention to the activities and practices of the pharmaceutical industry, and concentrates rather on other sectors of industry not all of which are as successful as the pharmaceutical industry. That sort of division, I think, is not very helpful. I think the DTI in some way should have an interest in the sectors which are at present under the aegis of the Department of Health and should know more about them.

553. Yes and OST can be the body that could bring them altogether and coordinate their operations. Let me take a case which is of interest to you through SERC which is space and of interest to the DTI which is of very very considerable interest to them because they have got an investment in space as well. What happens if those two bodies collide in their interpretations? Will that be settle by Cabinet Committee or will it be settled by ACOST?

(Sir David Phillips) In principle I think a collision between Secretaries of State ought to be resolved at a meeting of the Cabinet committee of departmental ministers with expenditures in science and technology. It would be served by this coordinating committee I have just been mentioning, chaired by the Chief Scientific Adviser, which would form an expert view to put to that committee.

Chairman

554. That would actually, Sir David, once again make the CSA role and the colleagues in the departments concerned that of fixing the priorities or at least determining the priorities?

(Sir David Phillips) At least. Yes, I think the role clearly is to understand what is happening, and by taking advice from the various bodies that exist or which we have suggested, form a view on the priorities that ought to be put to the ministers.

Sir Trevor Skeet

555. Surely if I could just pursue this for one further question. I mentioned this morning about the fast breeder. Somebody has taken a decision on this—whether it is in the interests of the UK I do not know—who would take that decision and how would it come about. The United Kingdom is not going to pursue any further activities in the fast

[**Sir Trevor Skeet** *Contd*]

breeder when the United States are going ahead with it and the Japanese are going ahead with it; almost everybody bar ourselves.

(Sir David Phillips) I would suppose that decisions has been taken as a result of discussions in what was the Department of Energy advised by ACORD, their advisory committee. That is related to, I suppose, proposals within the Department of Trade and Industry which have now been announced as government policy. As Sir Robin was saying, that is a question that has been rumbling for quite a long time. I do not doubt the ramifications of it will rumble even longer.

Mr Batiste

557. I am not entirely clear about the interaction between this coordinating committee and the chairmanship of the Chief Scientific Adviser dealing with the sort of situation Sir David has just described and the top level OST. It seems to be the sort of area precisely where you would be requiring advice from them. Where would you plug into that process then?

(Sir David Phillips) The high level committee would be of independent outsiders representing the interests of the world "out there". I am reminded of the Bromley joke about Washington being a hundred square miles surrounded by reality. I think we have to remember that all of this is intended to serve reality out there:, that top level committee would have representatives of the public interest, if you like. Now, the issues that they bring forward would, I think, be explored and recommendations as to how they might be pursued would be made by the co-ordinating committee.

558. On the specific question Sir Trevor was talking about in relation to the involvement of the British National Space Centre in the dispute between different departments about expenditure levels, possibly between Defence and DTI on the different priorities in satellites or something like that, I cannot quite see how in the system and in the resolution of that problem the advice of the co-ordinating committee operates on the system. Would it come into it when it gets to the disputes at Cabinet and the Prime Minister says "Here we have a report from the co-ordinating committee, now I would like to get a report from outside experts"? That seems to me an illogical way of dealing with problems like that. It should have happened earlier.

(Sir David Phillips) I do not quite see this proposed new high level committee operating in that way. We have to remember we are operating in the context of almost every department already having an advisory committee. I have already mentioned ACORD, the Advisory Committee to the Department of Energy. I have no doubt they have taken an expert view on this particular problem. That is, I think, an important point to make, that departmental committees in general become expert on their particular problems just as chief scientists within government departments become expert on the problems that are facing that particular government department. It then becomes, in my opinion, difficult for an external advisory committee to be expert enough actually to question the decisions that are being arrived at by that apparatus. So that is one of the reasons why we are proposing that the external committee should be a high level committee which is, if you like, bringing its own insights into the system, but is not directly involved in the administration in the sense of questioning executive decisions.

Chairman: Can we turn now to research council institutions?

Mr Williams

559. There have been suggestions in some of the evidence presented to us that the industry be allowed to compete for work in the public sector. How would your institutions like the Faraday centres or industrial laboratories compete for MRC or other research council work? How would you react to that?

(Sir David Phillips) Broadly speaking, I am in favour of that. It arose in part from an ABRC report on the support of biotechnology in the United Kingdom. The proposition that I agree with is this: suppose it happened that work in a government research agency, for example, or an industrial laboratory, if you want to press it to an extreme, was opening up a new area of science which it turned out was not of immediate commercial value to that company but would be of great importance to the science base generally to have developed. Then it would seem to me not unreasonable for an approach to be made to a research council to say "Here we have a new development. It is not of immediate concern industrially or commercially but it is scientifically very interesting. How would you like to support it, partly in order to bring the work out of the industrial laboratory or the government research agency into the university system and the science base?" So I do not see it as something that will be the general way of supporting research, I see it as a somewhat exceptional circumstance but I do not think it should be excluded.

560. The reverse flow, I presume, is working very well, industrial money coming into universities?

(Sir David Phillips) That is working quite well, depending on the industrial sector that you are concerned with. Perhaps I could make a point here which came up in the earlier discussion. You may be coming to it, Chairman, but the expression "technology transfer" always worries me a little because it seems to me to carry with it the implications of the linear model of how developments actually carry on. In fact, Sir Robin when he was asked about technology transfer began by talking about over-production of knowledge in universities. In my view, we are concerned with a highly interactive system in which new developments in the universities, yes, need to be conveyed to industry, but equally problems arising in industry have to be conveyed to research workers in universities and elsewhere so that they can be sorted

[**Mr Williams** *Contd*]

out. So technology transfer does not quite cover the problem. It is a much more complex interactive process than that.

Chairman

561. I think the Committee accepts that. What we are less knowledgeable about is what is the mechanism or method necessary to enable that interaction to take place. Is it a matter of research councils? Is it a matter of institutions which are connected to government or industry? How does this two-way flow react in such a way that it fundamentally affects the effectiveness of the science base in providing innovative technology?

(Sir David Phillips) One of the things that is often overlooked is that in some of our most successful industries there is not a problem at all. The interaction between, say, the pharmaceutical industry and the research system is extremely close and people in academic research understand the problems and interests of the pharmaceutical industry and the pharmaceutical industry understands what is being discovered in academic research. That is a very intimate relationship. The problem arises particularly in small to medium enterprises which have very little technological background and which hardly know how to approach the science base for help. That is the area in which schemes like the LINK scheme and the Teaching Company Scheme, both of them invented within the research council system incidentally, are intended to tackle the problem.

562. We are often, I think, referred to the pharmaceutical industry in just that way—that it appears to have no problem in relation to longer or short term development research investment for a high success rate, albeit over a long time. But it is also, certainly in this country, a Health Service provider. It is a very good thing, is it not, to be a major supplier to a major fixed customer of that size?

(Sir David Phillips) Undoubtedly.

563. Outside the Health Service there are not many others who are working for, as it were, a customer of that scale and size over such a long period of time. Is that not part of the problem?

(Sir David Phillips) I think that ensures that the major pharmaceutical companies have, as you are suggesting, to some extent a captive market, though it is fair to say that major companies use that backgorund to fight very hard for markets internationally. That is true, but perhaps I should not have restricted myself to the pharmaceutical industry. You could say almost the same about the chemical industry historically, which has had close contacts with academic research. It is when we get to the physics-based industries that we begin to see the difficulties.

Mr Williams

564. Why is it that we are so successful in the pharmaceutical and chemical industries and relatively far less successful in engineering? Could I put forward my theory on this? If you look at applications to medical schools—and generally now the qualifications for entry are three "A"s at A level—they have an exceptional pool of talent going into medicine, partly due to the status of the profession and so on, and generally in medicine people are pulled to dentistry and veterinary science, generally to the biological skills and sciences and away from mechanical engineering, mathematics and so on. Is there a culture problem here that goes back over several decades, that in the biological sciences you are looking at A level results and the quality of the science base is strong in biology, in chemistry, in medicine and in pharmaceuticals and it spins into those industries; whereas in engineering and physics they have not got the social status? I do not know what it is that makes up the mind of teenagers to go in for one selected subject or the other. Do you share that kind of view? Do you think that is part of the problem?

(Sir David Phillips) I think it is a highly complicated thing. There is no doubt that young people are for extremely good reasons attracted into medicine and biology and see them as vehicles for improving the quality of life and so on. They were in a previous period very strongly attracted into physics-based activities. There was a time post-war when the Atomic Energy Authority and related organisations employed a very large proportion of the active scientists in this country. It may be that those national enterprises—not leaving out defence of course—sucked up a great deal of the physics talent that might otherwise have gone out into industry.

Chairman: Sir David, mission accomplished! Thank you very much indeed for your time and for your considerable contribution to our work. We are most grateful to you.

APPENDICES TO THE MINUTES OF EVIDENCE

Letter from the Clerk of the Committee requesting Evidence (21 August 1992)

The Select Committee on Science and Technology is conducting an inquiry into the policy and organisation of the Office of Science and Technology.

The inquiry is a response to the centralising of Government activities on science by the establishment of the Office of Science and Technology, and to Mr. Waldegrave's invitation to the science community to respond to certain key questions. A White Paper on science and technology is expected early in 1993 which "will deal with organisational issues and set out ideas about the future of S&T in this country". (Annual Review of Government Funded Research and Development 1992, p. 3)

Mr Waldegrave's questions range extremely widely, and since the Committee wishes to report before Christmas, in order to influence the White Paper, it has decided, in this inquiry, to concentrate upon the organisational structure the department needs to fulfil its policy objectives and the way in which Mr Waldegrave will perform his function of co-ordinating government research and development as a whole.

The Committee would like to receive evidence from . . .

A copy of any submission you are making to the Office of Science and Technology would be most helpful. If this were not possible, there are some questions the Committee would particularly like you to address. They are:

- [1]What structure does the Government need to advise it on science policy?
- [1]Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate?
- [1]Is there a need for better co-ordination in funding policy for higher education institutions between the Research Councils and the Funding Councils? If so, how is this to be achieved?
- What should be the future role of ACOST and is it appropriate for the effective Chairman to continue to be an industrialist with a technological background, or should the Minister take the lead?
- [2]What should be the role of the Chief Scientific Adviser?
- Can any problems which arose from the previous ways in which science policy was co-ordinated be identified?
- Are there any areas which experience particular problems such as, for example, UK participation in international collaborative programmes?
- What should then be the objectives of the Minister as a member of the Council of Science Ministers in Brussels?

In any event, it would be helpful if you could include in your evidence a *brief* description of your organisation, setting out its responsibilities, staffing and the funding it receives.

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[1] The CBI, AIRTO, CIA, ABPI, AEA, FDR and the EEF were instead asked the following two questions:
- How can the process of turning research results into wealth creating technologies be improved? What might be the respective roles of OST and DTI in this?
- What structure does the government need to advise it on science policy? Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate?

[2] The five research councils and the Advisory Body on Research Councils were not asked this question.

Letter from Dr D H Roberts, Provost, University College, London (3 September 1992)

In response to your letter to the CVCP (21 August 1992) I attach a copy of my submission to Mr Waldegrave.

On the specific questions your Committee has posed:
Structure: Needs to clarify roles of ACOST and ABRC. The former has not been too effective in my view. Issues to address:

- (i) Should ABRC have executive powers on resource allocation? I think yes.
- (ii) Should ACOST (if retained) be seen to be more independent in its advice? Again, I think yes.
- (iii) If ABRC is to be purely advisory why do we need ACOST as well?

Existing Bodies: There is some scope for improving the demarcation between the various research councils. For views on ACOST/ABRC see above.

Co-ordination: Yes, the welcome recent changes in the dual support system still leave an unhealthy confusion around the full cost responsibility for research.

Future Role of ACOST: See above. First decide.

- (i) Is it necessary?
- (ii) Is it supposed to be independent?

The Chief Scientific Advisor: Is crucial. Should be listened to by not just OST but also the Treasury.

Problems: Many!

International Collaborative Programmes: Two kinds of issue:

- (i) Organisational—improved by OST representing UK in EC.
- (ii) Financial—still not grappled with despite previous Select Committee Report on Science Policy and the European dimension.

Objectives in Brussels:

- (i) Ensure that Framework Programmes take needs of basic science fully into account.
- (ii) Ensure cohesion between EC and national programmes.
- (iii) Find ways of minimising the demoralising impact of "attributions" on departmental policies.

Views on Proposed White Paper

As a contribution to the OST's deliberations I offer my answers to 12 questions[1] posed by William Waldegrave. I will try and keep my answers brief and hope that they remain comprehensible.

QUESTION 1

No simple answer—we are very successful in some areas. Fault does not lie with "science" but rather with industrial management which for too long:

- Ignored world markets.
- Neglected investment in manufacturing/process development.
- Failed to pursue policy of Total Quality Management.
- Failed to develop true marketing skills because of relationship with major monopoly customers (e.g., MOD, BR, BT, CEGB, etc.).
- Neglected continuing education and training at all levels, from Board to shop floor.

QUESTION 2

- (i) No.
- (ii) Probably not.
- (iii) Some do—but what about Ferranti, EMI, Plessey, say, in electronics?
- (iv) No simple answer other than lack of innovation is primarily a comment on deficient management. That deficiency can inhibit innovation in many ways:
    - Inadequate strategic thinking and market competitive analysis.
    - Excessive emphasis on short-term share price and dividend policy.
    - Lack of capability to understand role of new technology on future product policy.

The point about innovation is that it embraces all activities in a company—the "innovation chain"—see attached figures 1 and 2—so that poor management has many opportunities to inhibit the process.

QUESTION 3

More, *but:*

- There is a danger if the planners aren't competent. One way of minimising that danger is to subject plans to public comment.

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[1] For list of questions see p. 156.

- Basic science policy must retain a large element of responsive mode funding of "bottom-up" generated research proposals. Such responsiveness should be a priority within the overall plan.

QUESTION 4

No, I'm sure we don't. Several factors are relevant, including:

- Concern about cost of remaining in CERN, for example, undermines credibility of UK as a long-term research partner.
- EC funding formula makes it increasingly difficult for UK universities to participate as fully as is desirable. This issue was addressed in "Science Policy and the European Dimension" (HMSO), but was dismissed rather inadequately in Cm 1780, the DES response.
- Rightly or wrongly the fear of attribution (or retribution) has inhibited DES/Research Councils from identifying areas optionally served by EC projects. Having UK represented by DTI didn't help. Representation by OST should be major improvement.

QUESTION 5:

No.

- Consider cumulative cost/benefit of UKAEA over last 30 years—and overlap with CEGB in past.
- Great danger that existing Government establishments will have roles re-defined instead of closure.

QUESTION 6:

See 5.

Clearly the historical priorities of defence and nuclear energy need to be thoroughly re-assessed—including possibility that nuclear energy should be seen as "green" and be invested in.

QUESTION 7:

Probably has the right structure once it sorts out the relationship between ACOST and ABRC. However:

- Structure is only one element. Choice of people within the structure is key.
- Advising structure needs a degree of intellectual freedom and openness, not be embraced within the executive.
- The different challenge—and it is an old one—is to provide quality science and technology based advice direct to the Treasury.

QUESTION 8:

Several factors:

- Provide strong and stable financial climate within which innovative management can operate.
- Ensure adequate flow of well-educated young people, across full range of disciplines and with appropriate proportions at Ph.D/M.Sc. level.
- Protect the academic science base and its international competitiveness.
- Examine other models of financial encouragement to persuade companies to invest in innovation (not just "R" and "D").

QUESTION 9:

Yes, it can always be improved. There are some excellent precedents on which to build:

- The Teaching Company Scheme.
- CASE awards for Ph.D students.
- The JOERS and ALVEY programmes which greatly stimulated academic/industry collaboration in their fields.
- The LINK scheme looks more useful now, after a very shaky start.
- The SERC "Parnaby" Engineering Ph.D scheme.
- The new "pre-Faraday" scheme.

QUESTION 10:

I very much doubt it, to any significant extent—and it is dangerous to apply concept of identified industrial relevance to *basic* science. That would inhibit long-term innovation at the expense of a relatively small possible short-term benefit.

QUESTION 11:

Yes, undoubtedly, both in full-time education up to and including Ph.D and in developing industrial/academic collaboration in C.E. and T/technical up-dating via well-delivered short courses.

QUESTION 12:

Several steps:

- Be seen to take them and their advice seriously.
- Discourage talk about status.
- Take steps to improve their pay in those areas dominated by HMG. Academic salaries—and Ph.D stipends are the biggest turn-off and failure to address this would negate more positive progress on the issues raised in questions (1) to (11) above.

I hope that the above contributes to your deliberations.

FIGURE 1

THE INNOVATION CHAIN

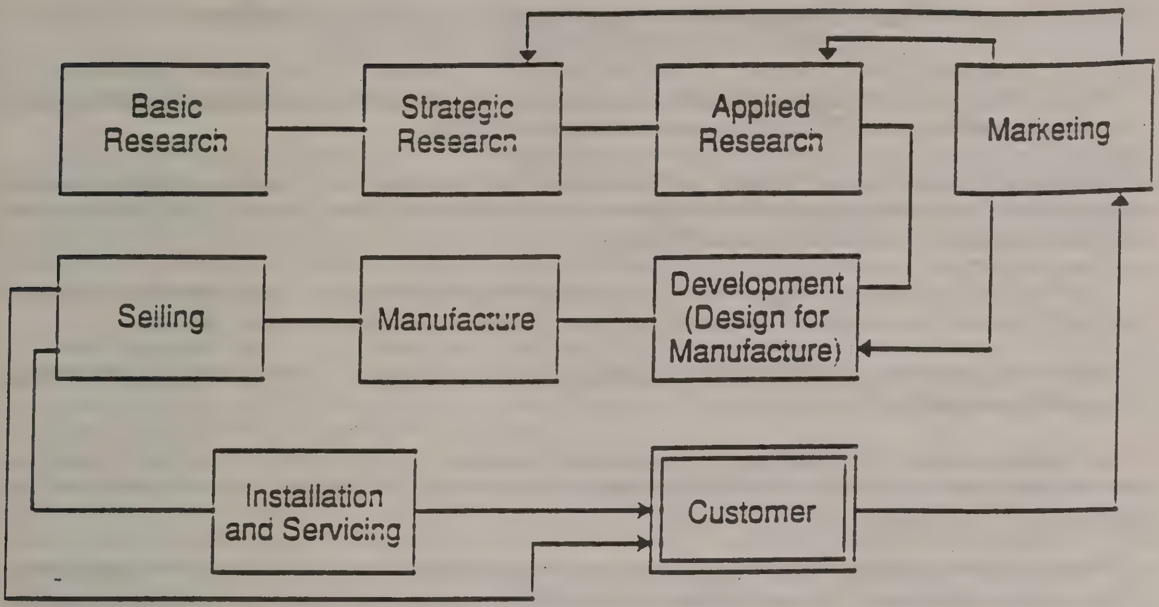
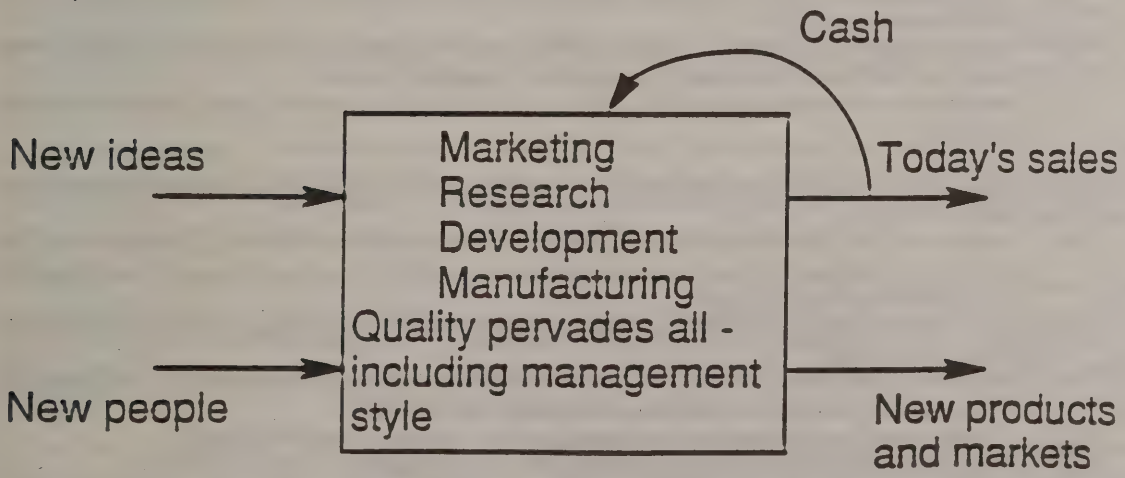


FIGURE 2

ENVIRONMENT FOR INNOVATION - AND PROFITABLE GROWTH



Appendix

CABINET OFFICE
Office of Public Service and Science

NEWS RELEASE (9 July 1992)

WILLIAM WALDEGRAVE LAUNCHES CONSULTATION ON SCIENCE AND TECHNOLOGY WHITE PAPER

William Waldegrave, Chancellor of the Duchy of Lancaster, today identified a number of key issues which he wished to address in the White Paper on science and technology.

He told the Foundation for Science and Technology that he would be consulting widely during the preparation of the White Paper, which would set out ideas about the future of science and technology in the United Kingdom and the Government's role.

"All of us share a common interest in science and technology and we have a deep conviction about the vital contribution it can make to our quality of life and our economic performance," he said.

"I look forward to presenting a robust case for science and technology in the years ahead and will look to your help in doing so."

Mr Waldegrave said the White Paper, which he hoped to publish in the early part of next year, would deal with organisational questions, but would also discuss ideas relating to the exploitation of science and the application of technology.

"While I have learned a lot since taking office from the many discussions I have had with representatives of the scientific community, I do not pretend to have all the answers. I am, however, beginning to identify some of the key questions:

(1) Why does the UK seem to be less successful than its competitors in translating inventions to the market place? Why is this more so in some industries than others?
(2) (i) Do we have an agreed measure of the capacity of an industry, or a firm, to innovate?
  (ii) Do we really know whether our firms are getting better or worse at innovation?
  (iii) Do technology-based innovative firms survive longer?
  (iv) Is the alleged lack of innovation a lack of good ideas, or finance, or what?
(3) Do we need more or less planning in Government science and technology?
(4) Do we get optimum benefit from our international collaborative programmes, especially in the European Community, and do they complement our national programmes well?
(5) Does the UK get the very best value for money from Government's considerable expenditure on science and technology?
(6) Are spending priorities right or would the Government be better advised to spend money in other areas of science and technology than the ones it funds at present?
(7) Does the Government have the right advisory structures at its centre to help it take decisions on priorities?"

Mr Waldegrave also referred to the questions he identified in the House of Commons debate on science and technology on 11 June:

(8) How can we best ensure that the strong upward trend in industrial R&D expenditure in the UK will continue and gather pace in the years to come, so that our record is as good as the best of our international competitors?
(9) Could the links between academia and industry be improved to encourage maximum exploitation of the science base?
(10) Is the UK working in areas of basic science which have less marketable derivates than those on which our international competitors concentrate their efforts?
(11) Is there scope for improved training opportunities in science and technology?
(12) What steps do we need to take to improve the status of scientists and engineers?

Mr Waldegrave added: "The last thing I want to do is to arouse hopes which I cannot fulfil, but I am keen to promote a debate on science and technology. I am sure this evening's discussion will provide a valuable part of that exchange."

NOTES FOR EDITORS

The White Paper is planned for publication in the early part of 1993.

Letter from Sir John Kingman, Vice-Chancellor, University of Bristol to the Clerk of the Committee (16 September 1992)

I have seen a copy of your letter of 21 August to the Chairman of the CVCP. I am sure that you will receive a full answer from the CVCP Office, but meanwhile you might like to see my own response to the questions asked by the Chancellor of the Duchy of Lancaster. If you feel that these will be helpful to the Committee, I should be happy for them to be placed on the table.

Letter from Sir John Kingman to Professor William Stewart, Chief Scientific Adviser, OST (25 August 1992)

I am writing in response to a letter of 20 July from William Waldegrave, asking for answers to be sent to you to some questions in his address to the Foundation for Science and Technology.

The Examination paper starts in para 15 with some questions which many have tried to answer, and which should have been studied by DTI if they were doing their job. I have little to add to what has often been written on these problems, but my experience on the boards of SmithKline Beecham and IBM(UK), and with BTG, has given me an admiration of the way the pharmaceutical and computer industries run their R&D. They know how to balance long-term speculative work against immediate applied projects, and how to observe the disciplines of the market without stifling creativity.

Such companies look to the universities, not primarily for direct help in their research, but for able graduates highly educated in a research environment. They also expect the science base to keep the UK in membership of the global scientific club, so that there are British scientists plugged into the networks through which scientific advances become known.

Para 16 raises the broad question of planning of Government science and technology. In applied areas the management of research is clearly necessary, and the difficult question lies in fundamental research. There are some areas that must be planned at a national level, big science like high energy physics, space and the genome. International collaboration must have national commitment. It is a political question to what extent basic research is carried out in universities or in separate research establishments.

The mistake is to extend national planning beyond this, by trying to decide centrally which areas of science are likely to be fruitful or applicable, or to put resources into glamorous "initiatives". The best science comes by backing the best scientists, who act as truffle hounds seeking out the problems of greatest potential. The history of the most striking technological advances starts with a scientific investigation driven by curiosity.

Paragraph 17 asks about gaining optimum benefit from international collaboration. My experience, for instance as the UK representative at CERN and ESA, was that the best strategy was to combine firm scientific commitment with a hard financial approach. This is respected by our partners, who often welcome a British insistence on value for money.

In the past however, we have made two sorts of tactical error. The first was to give the impression of infirmity of purpose. We talked about leaving CERN or the science programme of ESA while having no intention of doing so. On other occasions we delayed commitment to a new project (ILL for instance) and then joined too late to have any real influence. We must learn to take decisions, whether positive or negative, and stick to them.

The other mistake is to measure value for money in sterling. Scientific planning and diplomacy has been confused by the ups and downs of exchange rates. The biggest single contribution to effective international working would be for the Treasury to absorb the short-term fluctuations of exchange rates, paying subscriptions itself and charging the Research Councils at a realistic average rate.

Finally, paragraph 18 raises basic questions about the determination of Government priorities and advisory structures. Of course, the present pattern of public expenditure in science, as in most other areas, is the result not of reasoned debate but of political pressures and the lobbying of vested interests. Such is the nature of politics, but there is no reason why we should not move gently in the direction of greater rationality.

The odd thing about UK science policy is its reliance on advisory councils of the scientific great and good. Since the war we have had a series of acronymic bodies, which have gone through a predictable life cycle. They have started with enthusiasm, produced a few good reports (like Spinks on biotechnology), and then subsided into dignified inactivity.

Eventually the Government has noticed the snoring, and set up another body which has gone through the same cycle.

We would not try to run the NHS through a council of eminent doctors, or the economy by an advisory group of grand economists. Science is different because of the ignorance of most civil servants and ministers, and their consequent fear of taking decisions without advice.

But scientific advice is easy to come by when needed. The Government can call on the Royal Society and the Royal Academy of Engineering, on the more specialised learned and professional bodies, and on the various science policy groups. It gains little from the activities of its own committees like ABRC and ACOST, which only serve to diffuse responsibility.

That is why I have long advocated a proper Ministry of Science and Technology, into which I hope the OST will evolve. This will mean that it will have to develop its own full-time scientific capability, so that Ministers have proper in-house advice. This does not mean a large scientific staff, but a properly professional small group of people who understand science but also the role of science in an advanced industrial society. (I had such a group at SERC, which was of enormous help and put the Chairman in a strong position relative to other departments and councils.) I hope that OST can become strong enough to stand on its own, and cast away the crutches of ABRC and ACOST. It should listen to the scientific community, but with a sceptical and well-informed ear and with the ability to make up its own mind.

Memorandum submitted by the Association of Clinical Biochemists (17 September 1992)

The Association of Clinical Biochemists is a professional scientific body whose membership is predominantly drawn from scientific and medical graduates working in the National Health Service and related academic institutions. The response from the Association therefore, reflects views and experiences from a health care perspective.

CURRENT PROBLEMS AND PERCEPTIONS

The key problems in the sphere of science and technology at present can be summarised as:

- A reduction in investment in basic scientific research.
- A very limited investment in development, i.e., converting ideas into products, when it is well recognised that this is the more costly element.
- A reducing base of manufacturing industry in the UK and thus resources within industry to invest in new ideas.
- A reducing popularity of science at school.
- Reducing numbers of opportunities for training in research.
- Poor remuneration for scientists doing "scientific" work, e.g., compared with managers.
- Lack of career structure for research scientists in academic institutions.
- Poor commitment to training and career development.
- Limited consultation between professionals in the sphere of science and technology and policy makers.
- Poor financial commitment to research and development in the health service.
- Poor management of research and development in the health service.

PROPOSALS

There is a need for a change of culture that:

- Genuinely and demonstrably appreciates the value of science and the role of research and development.
- Recognises that both pure and applied research are necessary to create wealth from ideas.
- Encourages and rewards the entrepreneur.
- Enables effective management and accountability in researchers whilst not stultifying the intellectual climate.
- Encourages collaboration between the manufacturing industry and scientific research in health care, e.g., joint funding ventures.

The present opportunities to give advice on science policy in the health care environment are limited. Thus there is no formal mechanism for practising scientists to advise Professor Peckham's CRDC; this could be readily achieved through small sub-committees with membership drawn from professional bodies such as this Association, the Royal College of Pathologies, etc.

The funding Councils are seen as having too great an emphasis on the support of basic science.

There is a huge gap between practising scientists, decision makers and politicians. It appears that there are very few instances where good scientists are attracted into government and politics in general. Consequently the science voice is weak; of course there is also a responsibility for science to speak up!

It is important that the Minister is seen to be involved in science and technology; it would be most appropriate for the Ministry to jointly chair ACOST with a scientist or industrialist.

One of the major roles of the Chief Scientific Adviser (and his office) should be to gather, evaluate and report on scientific development to government.

In practice, participation in international collaboration programmes (including Europe) is a bureaucratic nightmare which consumes huge human scientific resources. If this burden cannot be reduced then more help needs to be given to reduce the load on scientists who wish to be involved.

A submission to the The Office of Science and Technology by Smith System Engineering Ltd (17 September 1992)

A science and technology exploitation policy for the UK

1. Introduction

This paper is offered as a contribution to the White Paper on the future of science and technology in the UK being prepared by the Office of Science and Technology. It proposes a policy based on three premises:

- That the exploitation of science and technology benefits the economic health of the nation and is to be encouraged.
- That market forces should be allowed to direct that exploitation wherever possible.
- That government should take action to bring about exploitation where market forces are deficient.

2. The process of exploitation

The spectrum of activity in science and technology is wide. At one end lies academic research which generates a pool of scientific and technological knowledge by means of projects which are, in most cases: motivated by curiosity, selected by peer review and funded by the public sector.

At the other end of the spectrum lies industrial development of products by means of projects which are, in most cases: motivated by profit, selected by market forces and funded by the private sector.

Exploitation occurs when bridges between the two ends of the spectrum allow the transfer of scientific and technological knowledge into products. It has been assumed in much previous analysis that there is a sequential, continuous process by which academic research is transformed into industrial development. It is now becoming apparent that this so-called linear model applies in some industries and technologies but that there are many examples where the process is neither sequential nor continuous. In these cases, the industrial innovation may precede the underlying science needed to understand and optimise that innovation or potentially useful academic research may lie unexploited because of the unbridged gulf between the two communities.

3. Principles of an innovation policy

Public effort should be directed in two ways:

- To reinforce bridges where the linear model does work.
- To create bridges where the linear model does not work.

It is vital to recognise that these regimes are qualitatively different. A single policy intended to address both is likely, in practice, to address neither. This is the case of the historical policy adopted by the UK. Its lack of success is hardly surprising since it is founded on two mutually contradictory premises:

- Projects must not be near-market (to avoid being seen as subsidy).
- Public funding must not exceed 50 per cent of the costs (in order to use market forces to pick sensible projects).

These premises are clearly mutually contradictory since the latter requires market forces to be used to select projects which are, according to the former, not of interest to the market.

4. Reinforcing existing bridges

In many areas of industrial activity the two ends of the scientific and technological spectrum already meet, bridges exist and knowledge and expertise flows from university to industry in response to market forces. An example of this process is the exploitation of academic research by pharmaceutical companies.

These areas are market-driven (even if the eventual market may not be realised for a long time) and the linear model works. Government can encourage greater activity by three measures:

- Fiscal incentives such as negative Corporation Tax for industrial research.
- Improved legal protection of Intellectual Property Rights to allow companies to recover their investment, especially in physics-based innovation.
- The establishment of mechanisms such as a network of Faraday Centres to bring together academic and industrial staff and to encourage the transfer of generic technologies between industries.

All of these measures encourage investment in near-market activities without requiring Government to intervene in the selection of projects or areas of technology as all are selected by profitable companies. These measures are particularly appropriate for action at a national, rather than international, level since they are essentially local, involving individual researchers and companies.

These actions will lead to *short-term benefits in existing markets.*

5. Creating new bridges

In areas of industrial activity where the two ends of the scientific and technological spectrum do not meet, bridges do not naturally exist and existing market forces will not bring them into existence. By being the customer for projects with challenging goals, government can create a market which in turn will lead to development of exploitable technology. Some examples of the use of this approach are the US plan to monitor the environment from space, the TGV train in France and the world-wide programme to map the human genome.

Commercial success depends on anticipating and creating new markets and it is through projects of this type that companies can find new opportunities. As the customer, government can select contractors by competitive tender and thus ensure that market forces thereafter determine the conduct of the work.

The goals should be technically ambitious and involve technologies in which the UK has strength. They should be selected by agreement of government, industry and academia and be chosen for their social value in fields such as the environment, health, transport, education or defence. Smaller scale projects could be undertaken by Faraday Centres, using untargeted public funding, since they will be ideally placed to ensure the rapid dissemination and exploitation of opportunities that emerge.

There is great merit in applying these principles on a European scale since, as with any activity whose return is external, the returns are proportionately greater if the costs are spread over a larger club of beneficiaries.

These actions will lead to *long-term benefits in new markets.*

6. Mechanisms

It is often claimed in the UK that "government cannot pick winners". The policies proposed here leave to market forces the selection of technologies and companies but calls on government to create a market for advanced projects.

Taxation can be employed to encourage existing bridges by offering support proportional to audited industrial R&D. There is no reason to believe that such fiscal measures would be any more subject to fraud than are other tax allowances.

A new mechanism is required to select and purchase the advanced projects which will lead to the creation of new bridges. The US Defense Advanced Research Projects Agency has these terms of reference and interprets them more broadly than the "Defense" in its title might imply. The UK needs a similar agency (UKARPA?) to provide a forum for government, industry and academic researchers to agree on the choice of goals and to be the demanding customer for challenging projects that will force industry to innovate.

7. Recommendations

It is recommended that market forces should direct and provide the resources for the exploitation of science and technology wherever possible and that government should take action where market forces are deficient and, in particular, should:

- Recognise that the policies needed to reinforce existing bridges and to create new bridges are different.
- Use fiscal incentives to encourage successful companies to pursue market opportunities to reinforce existing bridges.
- Establish an advanced projects agency to select and purchase challenging projects to create new bridges.

Letter to the Clerk of the Committee from the Royal Academy of Engineering (18 September 1992)

You wrote to Sir William Barlow on 21 August asking for the Royal Academy of Engineering's input to the deliberations of your Committee on the policy and organisation of the OST. You suggested that a copy of our submission to the OST would be helpful and you asked for this by 21 September.

I am not able to let you have a copy of our submission[1] to the OST as it is not yet complete. I will be in touch with you again in a few weeks time.

In the meantime I enclose the background information you requested:
(a) "An Introduction to The Academy".[2]
(b) The Academy's 1991-92 Annual Report which gives a good summary of our activities.[2]
(c) An organisation chart of our Council and Committees.
(d) An organisation chart of the Secretariat.

Our budget this year is approximately £5.4 million from a variety of sources, in round figures:

	£ million
Grant in Aid (Science Vote)	1.65
The Gatsby Trust (Education	1.00
DTI Contracts	1.00
Industry	1.40
Other Trusts	0.10
Income from Capital/Subscription	0.25
	5.40

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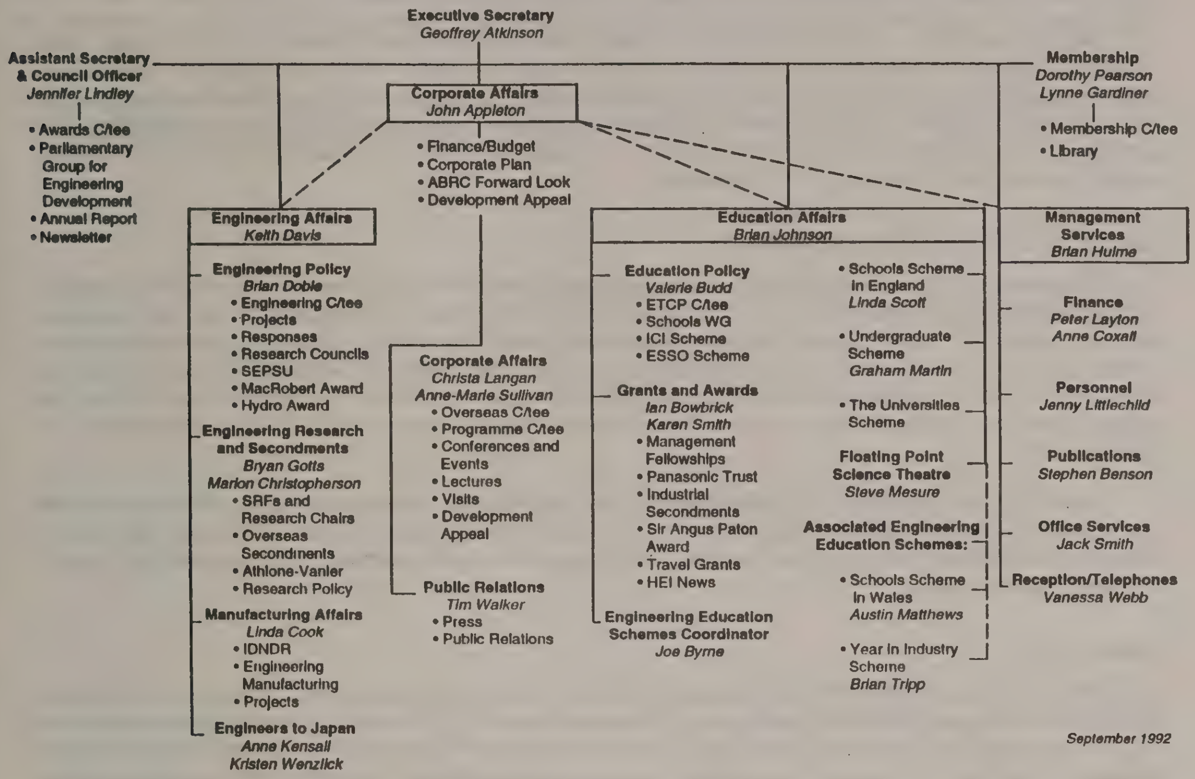
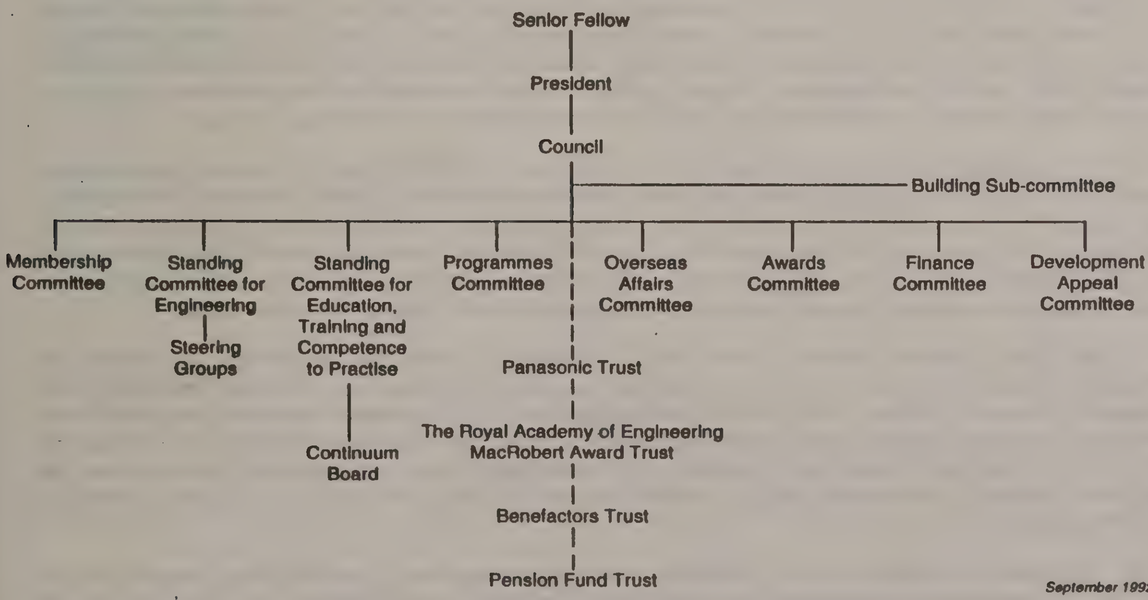
[1] See Appendices to the Minutes of Evidence p. 217.
[2] Not printed.

THE ROYAL ACADEMY OF ENGINEERING — *Secretariat Structure*



September 1992

THE ROYAL ACADEMY OF ENGINEERING
Council and Committee Structure


Senior Fellow
President
Council
Building Sub-committee
Membership Committee
Standing Committee for Engineering
Steering Groups
Standing Committee for Education, Training and Competence to Practise
Continuum Board
Programmes Committee
Overseas Affairs Committee
Awards Committee
Finance Committee
Development Appeal Committee
Panasonic Trust
The Royal Academy of Engineering MacRobert Award Trust
Benefactors Trust
Pension Fund Trust

September 1992

Letter to the Clerk of the Committee from the Committee of Directors of Polytechnics (21 September 1992)

1. I am replying to your letter of 21 August to the Secretary, Mr Blows.

2. We are not yet in a position to submit to the Office of Science and Technology a response to Mr Waldegrave's invitation of 20 July to let him have the views of the CDP on the future of science and technology and the Government's role in it. I cannot therefore let you have a copy of our response but will do so when it is available. I have, however, attempted in the later paragraphs of this letter to distil from the responses so far received from our members some comment on some of the questions posed in your letter in order to meet your deadline of 21 September.

Committee of directors of polytechnics

3. You also asked for a brief description of our organisation and I will attempt to do this before moving on the commentary on your questions. The Committee of Directors of Polytechnics is the representative body of the heads of 39 institutions of higher education in Great Britain. Most of our members are Directors or Principals of the former polytechnics though three of our institutions in Scotland did not use the title "polytechnic". All but one of our member institutions were given university status under the Further and Higher Education Acts earlier this year and most have already changed their names to incorporate the university title.

4. The CDP office is funded by subscriptions from the member institutions and in effect provides the Committee's secretariat under a chief executive. The present staff number some 18 people. The CDP's function is to represent the views and interests of the members to Government, other outside bodies and, of course, to Parliament.

Commentary

5. The structure needed by the government to advise it on science policy must, in our view, be one that bridges the existing gap between industry and the academic world. The structure should also be capable of bringing into play the advice of *young* scientists and technologists since they are more likely than older colleagues to be both fully up to date in their disciplines and unaffected by political views and prejudices.

6. Insofar as the existing advisory bodies do not meet the criteria in paragraph 5 above they lack optimum appropriateness. As to the higher education funding councils, these are in process of being reconstructed following the 1992 legislation and it is therefore too early to comment on their appropriateness. Our experience of the former Polytechnics and Colleges Funding Council was that it had a good understanding of the importance to the nation of the teaching of science and technology at a high level: following the publication of the report of the PCFC Committee of Enquiry on Research in the PCFC Sector (1990) the PCFC allocated pump-priming funds for research to its institutions on a competitive basis.

7. It is too early to make a judgment on the quality of co-ordination between the research councils and the funding councils in view of the newness of the latter. Our impression from the sidelines was that co-ordination between the UFC and the research councils was far from perfect. Our members see it as one of the functions of the OST to provide an overarching supervision of the work of the various channels of public funding for research in science and technology. Amongst the considerations the OST should take into account is the need for the planning of funding in these fields to be medium to long term rather than short term in recognition of the sometimes long lead times on research and development projects.

8. Our members have made no comment so far on the role of ACOST. They do, however, stress in their responses the need for a shift in funding emphasis from basic research to applied research. It seems to us that this need is more likely to be heeded by a committee chaired by an industrialist/technologist than by one chaired by an academic. By the same token it would be reasonable to expect that if the Minister took the chair himself he would lead the Committee to a proper emphasis on application and exploitation of scientific and technological research in the interests of the economy and the nation at large.

9. The Chief Scientific Adviser's main role is of course to advise the government on science and technology matters. His advice should be proactive as well as reactive, i.e., he should be pressing for adequate government funding for high level teaching and research in the sciences and for an improved basis of training in science and technology for young people of school age through the National Curriculum and NVQs. Part of his remit should be to enhance the status of scientists and engineers in British culture. He could well also have a role in encouraging collaboration between higher education and industry in research and development.

10. The main defect identified by our members in the previous ways of co-ordinating science policy is the lack of emphasis on **application** and **exploitation**, resulting in the notorious tendency for British discoveries and inventions to be exploited abroad.

11. Our members have offered no comment so far that would be relevant to your last two questions —other problem areas and the objectives of the Minister as a member of the EC Council of Science

Ministers. No particular dissatisfaction has been voiced about UK participation in international collaborative programmes. The Minister's objectives in Brussels should presumably be mainly twofold: to ensure that Britain receives a fair share of EC funds for scientific and technological research; and to press for collaborative European ventures in these fields which reflect Britain's needs and its aspirations for the wider world.

12. I am sorry not to be able to give a more substantial response to your letter but I hope the Committee will nevertheless find some of the foregoing helpful.

Letter and memorandum submitted to the Chancellor of the Duchy of Lancaster from Walter Herriott, Esq, Centre Director, St John's Innovation Centre (22 September 1992)

I write as Director of the St John's Innovation Park in response to your questions.

The Park was founded by St John's College in Cambridge in 1987 to provide a supportive environment to early stage high technology based businesses, to encourage technology transfer, and to make an adequate return on capital employed on the property venture for the College. For further information please see attached "Facts" booklet.

The Park currently has 80 tenant companies, on average has had an occupancy rate of 90 per cent, and is providing an acceptable return to the College. Only 4 per cent of tenant businesses have failed to survive their first four years due we believe to the techniques that we have developed. The Park has also contributed to enhancing technology transfer mechanisms in Cambridge, and I enclose a paper on the proposed Cambridge Enterprise Forum.

Currently the Park is assisting in promoting technology transfer initiatives in the United Kingdom, France, Hungary and Russia.

For the last two years I have been the full-time Director of the Park. My original career was in banking and I was a Barclays Bank Manager from 1975 to 1988, gaining a reputation for understanding the needs of small and medium sized high technology enterprises. Immediately prior to becoming the Director of the Innovation Park (after leaving Barclays) I was a Director of Coopers & Lybrand.

I would like, therefore, to comment on the questions put to the committee from the perspective of someone who is very involved in, and concerned about, the growth of small and medium sized technology based businesses.

QUESTION—WHY DOES THE UK SEEM TO BE LESS SUCCESSFUL THAN ITS COMPETITORS IN TRANSLATING INVENTIONS TO THE MARKET PLACE? WHY IS THIS MORE SO IN SOME INDUSTRIES THAN OTHERS?

Comment—The Cambridge experience seems to show that we are not necessarily less successful than others, particularly in creating and sustaining spin-out companies and promoting technology transfer. At least 700 technology based businesses have been formed in the vicinity of Cambridge in the last 15 years, and the survival rate of these businesses is remarkably high. It has been argued, however, that Chalmers University in Sweden, appears to be equally, if not more, successful. A closer look at their statistics however seems to indicate that they define a high tech spin-out much more broadly than we do. Certainly my recent experiences in France (where I visited Bordeaux, Caen, Nice and Strasborg) indicate that there are far less academic spin-out technology based businesses in the **whole** of France than in Cambridge alone!

One of the difficulties is meaningful official statistics. UK industrial classifications do not easily show up genuine high tech businesses. We recently carried out work for Sussex County Council and it was only by the "chain letter" approach that we were able to identify the number of genuine high tech companies in that county. In the United Kingdom, we seem not to put as much importance on the veracity of the figures as perhaps we should, for instance, I understand the Cambridgeshire County Council database lists 900 high tech companies, but a recent study by Elizabeth Garnsey of the University Engineering Department indicates a considerable number of "fictitious" entries.

We must be more precise in our definitions and place more importance on the quality of the statistical evidence available. As a generalisation we do not appear to be comparing like with like, sometimes to our detriment.

QUESTION—DO WE HAVE AN AGREED MEASURE OF THE CAPACITY OF AN INDUSTRY OR A FIRM TO INNOVATE? DO WE REALLY KNOW WHETHER OUR FIRMS ARE GETTING BETTER OR WORSE AT INNOVATION? DO TECHNOLOGY BASED INNOVATIVE FIRMS SURVIVE LONGER? IS THE ALLEGED LACK OF INNOVATION A LACK OF GOOD IDEAS, OR FINANCE, OR WHAT?

Comment—I do not believe that we have the information available to measure capacity to innovate either quantitively or qualitatively.

The major problem that I face is persuading providers of finance that high tech does not necessarily equal high risk as far as small and medium size enterprises are concerned. For instance, the failure rate on the St John's Innovation Park 4 per cent in the first four years of our operation, compares to a figure of 40 per cent for business generally.

My experience at Barclays, in the late 1970s and early 1980s based on the Bank's Regional Bad and Doubtful Debt Analysis, confirms that high tech is actually a low risk activity if financiers know what they are doing. Recent work by Elizabeth Garnsey on failure rates amongst established Cambridge Phenomenon companies indicates a low figure—a mean annual rate of 3.7 per cent since 1985.

Despite all this evidence I am continually advised by bankers and venture capitalists that they are not interested in high tech businesses because they are too risky. I recently contacted the Economics Department at Barclays Bank as they stated in one of their publications that the banks failures were very high in this field compared to other types of lending. Barclays has either forgotten or not learned from their Cambridge experience of 1978-85 or is not recording accurate statistics!

Finance is identified by the majority of our tenants as the major factor inhibiting growth. This is probably true and becoming more so. It is particularly concerning that, in my view a considerable number of the successful Cambridge companies financed by Barclays in the early 1980s would not now be supported by any bank. It is also true, however, that companies lack the marketing and managerial skills "in-house" to take them successfully to the next stage of growth. Only Domino plc amongst all the Cambridge Phenomenon companies has managed to retain its independence and grow to a reasonable size. There are cultural reasons for this failure to grow inherent in the aspirations of the founders. The majority of high tech companies are started because the founders are interested in the technology involved rather than because they want to run businesses as businesses.

Where there is a desire for growth, it is extremely rare for the founder to have the necessary skills to run a more mature and bureaucratic company or to recognise when he needs to bring in professional management.

In my experience the typical life of a high tech company is probably five to seven years as an independent entity if the founders have genuine growth aspirations. The company is usually then sold to a US or European company. The "sell-out" of the Cambridge computer aided design companies in the early and mid 80s to Americans is an indication of how medium and large sized UK plcs fail to spot market opportunities, and support our own small technology based businesses.

QUESTION—DO WE NEED MORE OR LESS PLANNING GOVERNMENT SCIENCE AND TECHNOLOGY?

Comment—It is easy to blame the Government for all our ills. The thrust of Government policy comes across as being to "reduce taxation and all will be well". The policy of course is much more sophisticated than that, nevertheless, currently our European competitors, particularly the French, seem to have a much more structured approach and a more positive attitude towards technology transfer. I understand the German approach to financing early stage technology based businesses involves much more state subsidy than in the UK, but I do not have first hand evidence myself to support this view. It is, however, a genuine and widespread perception. Whatever the truth there is still a case for the "infant industry" argument as far as small and medium size British high technology companies are concerned. The attitude, however, of large and medium sizes British businesses towards their smaller brethren and to technology in general is also a genuine problem.

The plethora of Government schemes, and certainly the organisations handling them is also confusing. Why, for example, is the Small Firms Loan Guarantee Scheme not administered by the DTI, and how does the Foreign Office have the experience and skill to decide who should be supported under the "Know How" fund?

QUESTION—DO WE GET OPTIMUM BENEFIT FROM OUR INTERNATIONAL COLLABORATIVE PROGRAMMES, ESPECIALLY IN THE EUROPEAN COMMUNITY, AND DO THEY COMPLEMENT OUR NATIONAL PROGRAMMES AS WELL?

QUESTION—DOES THE UK GET THE VERY BEST VALUE FOR MONEY FROM GOVERNMENT'S CONSIDERABLE EXPENDITURE ON SCIENCE AND TECHNOLOGY?

QUESTION—ARE SPENDING PRIORITIES RIGHT OR WOULD THE GOVERNMENT BE BETTER ADVISED TO SPEND MONEY IN OTHER AREAS OF SCIENCE AND TECHNOLOGY THAN THE ONES IT FUNDS AT PRESENT?

QUESTION—DOES THE GOVERNMENT HAVE THE RIGHT ADVISORY STRUCTURES AT ITS CENTRE TO HELP IT TAKE DECISIONS ON PRIORITIES?

QUESTION—HOW CAN WE BEST ENSURE THAT THE STRONG UPWARD TREND IN INDUSTRIAL R&D EXPENDITURE IN THE UK WILL CONTINUE AND GATHER PACE IN THE YEARS TO COME, SO THAT OUR RECORD IS AS GOOD AS THE BEST OF OUR INTERNATIONAL COMPETITORS?

It is difficult to answer this group of questions because I do not have the necessary facts at my finger tips and I only speak from a small and medium size enterprise perspective. The general impression created by Government activity, is that it lacks focus and is "penny pinching" compared to our international competitors. For example, I believe that French spending on civil R&D will, within five years, be higher than ours and the Japanese are also thought to be increasing Government involvement in R&D, whereas our national contribution in the recession is falling or at best "frozen". The Government appears to be less supportive in setting up the Faraday Centre than the Germans were in funding their equivalent institutes. It may well be that these perceptions are not correct. If so the Government has a PR problem.

The Government certainly must improve its understanding of the needs of small and medium size businesses, they are not simply "large companies shrunk small". The Government seems to believe that any company employing under 500 people (or is it now 200?) is small. A more precise definition of what constitutes a small or medium sized business might be helpful. There is a world of difference between the needs and requirements of a high tech company employing five people and one employing 495 people! I do appreciate that any distinction will be arbitrary but I believe that research carried out by the London Business School on high tech businesses indicates that the needs of companies employing less than 10 people are different from those employing more than 10 people and the needs of those employing more than 70 people are different again.

There are three areas, however, I would like specifically to comment on:

(A) The Small Firms Loan Guarantee Scheme. It seems logical that this scheme should be run by the DTI. In my view it is a very useful scheme, and when I was a bank manager it was successfully used to support early stage technology businesses. I would like to see the scheme targeted at wealth creating businesses with another scheme designed to reduce unemployment. Because the needs are different the schemes should be different. It should be possible, for example, to build in an equity kicker to a loan scheme designed to support a wealth creating businesses (i.e., high tech) which would not be possible with a scheme designed to decrease unemployment. As the banks apparently have such a poor record, why not, experiment in one region and make the scheme available through, or vetted by an intermediary, i.e., a technology consultancy or an Innovation Centre as well as through the current channels. After all these days most of us are acting as bankers without security. We are supporting our tenants when bankers will not, and to date we have been very successful!

One of the problems about the scheme, and perhaps the reason why failure rates have been relatively high, has been the absence of a "walk away" cost. As a cynical ex bank manager, I prefer some form of personal commitment and this could be achieved by making the individual liable personally for 10 per cent of the debt even if he has already pledged all his existing assets. My own view as a bank manager was that the future earning power of high tech company directors should enable them to repay say £10,000 over a term of say 10 years. My experience was that this did tend to concentrate the mind if the business got into difficulties even if the individual had pledged all his existing assets.

In my experience it was essential that the scheme was monitored on a monthly basis by means of budgets and rolling cash flow forecasts. How often has this been insisted on by the operators of the current scheme?

If the scheme does continue, the interest rate and commission charges should be capped for any institution which wishes to be a provider. Banks should not be able to charge more than, say, two over base, and there should be standard review and commission charges laid down by the Government.

(B) Regional Technology Centres. It would be very interesting to see a cost benefit analysis of what actually has been achieved by the Governments substantial investment in Regional Technology Centres. Is it not time to roll the survivors into the TECs? Making money out of technology transfer is extremely difficult and long term. There is a role for Regional Technology Centres to play, though it is difficult to see how they can perform this role without continuing subsidy. The attached document on the Cambridge Enterprise Forum indicates, I think, the problem. It is quite possible to monitor the progress of Regional Technology Centres against qualitative targets rather than trying to force them to become commercial animals in a very short time scale. I would have thought that it is quite possible to set such targets to the benefit of "United Kingdom plc" which would be politically acceptable.

(C) SPUR/SMART. SPUR is not aimed at small high technology companies and SMART is an annual competition for such companies. I have 80 tenants in this Centre, most of whom would benefit from a SPUR Scheme specifically targeted at them, rather than an annual competition where there are winners and losers. The DTI's accountants do not always seem to understand how to read a small technology company balance sheet. I believe that the position here is actually improving but there is some way to go yet.

QUESTION—COULD THE LINKS BETWEEN ACADEMIA AND INDUSTRY BE IMPROVED TO ENCOURAGE MAXIMUM EXPLOITATION OF THE SCIENCE BASE?

Comment—There are a number of problems here. The best UK companies seem to be as good as any in the world. Anecdotal evidence, however, seem to imply that the second division stock exchange companies are not really interested in academic industry links. Academics themselves can appear smug and complacent about their role in society. A recent mini survey in Cambridge University found that 80 per cent of scientists were interested in commercialising their technology but the majority did not know how to do so! Does our educational system really breed people with such little initiative? Undaunted, however, we have set in place a series of workshops, seminars and posters to try to encourage the commercialisation of research. We are grateful to have been supported this year by the DTI ROTT Programme.

A fundamental problem is the quality of University Industrial Liaison Officers. Some of the holders of this post that I have met (outside Cambridge) are doing more than one job or appear to have been put out to grass early by large organisations. There is probably absolutely nothing wrong with the quality, integrity or effort of such people, but it would be nice to see the status of this post raised and bright young people being employed with a focus on genuine technology transfer.

Industrial Liaison Officers appear more interested in the glory of collaboration with Rolls Royce, ICI, etc. This is obviously the correct strategy given limited resources but it would be nice to see more proactive attempts being made by Industrial Liaison Officers to introduce technology to SMEs in their catchment area, and to encourage the growth of SMEs from within the Universities. Some Universities are obviously outstanding, but I do feel that the general standard and performance could be substantially improved.

I doubt very much whether there are accurate statistics on technology transfer. For example, no one in Cambridge University as far as I can ascertain, currently knows:

- How many patents are filed from within the University each year.
- How much revenue is being created by direct consultancy/research projects between the University and industry.
- How many jobs are being created, directly and indirectly in the area, through technology transfer initiated from an HEI.

If we do not even know how we are doing, how can we possibly evaluate our performance!

In my experience Science Parks have too often become nothing more than pleasant property developments. Direct Government support for genuine Science Parks (as defined by the United Kingdom Science Parks Association) might provide some beneficial results for the nation. The Unicité concept, which has been developed in Cambridge, applied in France by Tartan International and is under consideration in Russia, should be evaluated to see whether it does improve interactions between university and industry.

QUESTION—IS THE UK WORKING IN AREAS OF BASIC SCIENCE WHICH HAVE LESS MARKETABLE DERIVATIVES THAN THOSE ON WHICH OUR INTERNATIONAL COMPETITORS CONCENTRATE THEIR EFFORTS?

QUESTION—IS THERE SCOPE FOR IMPROVED TRAINING OPPORTUNITIES IN SCIENCE AND TECHNOLOGY?

QUESTION—WHAT STEPS DO WE NEED TO TAKE TO IMPROVE THE STATUS OF SCIENTISTS AND ENGINEERS?

Comment—The evidence from Cambridge would seem to indicate that we have plenty of exploitable technologies. The basic problem is that the companies that eventually exploit those technologies on an international scale are often foreign based operating in larger markets. Two University spin-out companies that I helped in the early 1980s have recently moved the centre of their operations to the United States. When asked why the founder's answer was "Start in America. The UK market is too small and obtaining finance far too difficult. Today we would never get the finance to even start. We are leaving the sinking ship in a somewhat depressed state. When taking into account the debtor cover for our overdraft the banks deduct overseas debts, I thought we needed to export to survive!" The Government might consider how bank lending to businesses that do export could be encouraged. Perhaps by simplifying the export credit scheme.

There is, of course, the perennial problem about the status of scientists and engineers. It does not seem that there is a short term solution. The answer must lie in increasing the status of business and science and technology within the educational system. Schools do not appear to help matters. When I became the Director of the Innovation Centre I offered two schools in the Cambridge area the chance to visit the Centre and make sure of our facilities for geography, economics, business studies, or to talk to some of our tenants about careers. Despite reminders I have had no takers since the offer was first made. It may well be that we are not a very good reference site, but in the last 12 months we have been visited by delegations from over 45 countries and we keep getting overseas referrals!

In conclusion may I say that I am deeply concerned that we are too complacent about our position in the world. We live in a post industrial society, have no comparative advantages apart from the skill of our people and in my experience our international competitors appear to be currently much more interested in technology transfer and the creation of small- and medium-sized high technology enterprises than we are. We talk too much about redistributing wealth, and too little about creating it.

- The statistics that do exist on technology transfer appear to be of poor quality and are often dressed up for political purposes.
- Obtaining finance is not the only problem that faces growing businesses but it does appear to be true that it is much more difficult to obtain bank finance to start even quality high tech businesses now than it was 10 years ago. This is a really genuine concern. The banks are shell shocked, and to quote one of my former colleagues, now a regional director, "We have reduced all lending to the factor of the lowest common denominator. If we carry on with our present policy there will be no enterprise in the UK in five years' time". There is a venture capital gap and it is widening and the initiatives to create local investors networks are unlikely to be successful without strong tax incentives which seems to have been removed with the total abolition of the BES Scheme.
- To overcome the venture capital gap we have to encourage corporate venturing. The tragedy is that it is much easier to form strategic alliances between small UK companies and US companies

than it is between medium to large UK companies and small UK companies. The Innovation Centre experience is that such alliances, properly managed, help small companies get into markets and grow far more quickly then they could by operating in total independence, or through obtaining institutional venture capital.

— Insufficient effort is being put into creating a genuinely positive business environment for high tech businesses to operate in. By contrast the French appear to have a much more coherent approach to the problem and ironically are using a number of UK consultants to assist and advise them.

In summary I do fear that overall we are too complacent in the United Kingdom, and I hope that a more coherent and positive strategy does emerge from the answers supplied to the questions put by the Chancellor of the Duchy of Lancaster. At grass roots level my tenants and clients are looking to Government to provide a much more positive approach.

Letter to the Clerk of the Committee from the Association of Independent Research and Technology Organisations (28 September 1992)

I am replying on behalf of The Association of Independent Research and Technology Organisations (AIRTO) to your letter of 19 August 1992 to John Bennett, Secretary General in which you asked for evidence for the enquiry being conducted by the Select Committee on Science and Technology into the policy and organisation of the Office of Science and Technology. Our evidence is based on a letter which I have submitted to Mr William Waldegrave in answer to his own request for our views.

I should like to put forward three linked, general principles that AIRTO believes to be vital for the success of a policy to encourage better exploitation of science and technology:

- Recognition of the difference between invention and innovation.
- The pivotal role of research and technology organisations (RTOs).
- The need for a higher level of strategic direction.

RECOGNITION OF THE DIFFERENCE BETWEEN INVENTION AND INNOVATION

The distinction between invention and innovation is most important: The OECD "Frascati Manual" provides a useful definition of innovation:

> "Scientific and technological innovation may be considered as the transformation of an idea into a new or improved saleable product or operational process in industry and commerce or into a new approach to a social service. It thus consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service. R&D is only one of these steps".

The last sentence is underlined in the original and reinforces the need for a balanced policy which encourages the whole of the innovation process, not just the first stage of invention.

The Prince of Wales' Working Group on Innovation, in its Interim Report, made two principal recommendations:

- The status, role and capability of intermediate organisations engaged in technology development and transfer be substantially enhanced.
- Focus, and a higher level of strategic direction, are required if the delivery of support for innovation is to be both effective and efficient.

These are the subjects of the other two general principles raised by AIRTO.

THE PIVOTAL ROLE OF RTOs

Independent research and technology organisations (RTOs) provide a powerful contribution to industrial innovation through the four services which they provide: contract research, collaborative research, specialist consultancy and technology transfer. In particular, they have a special role in technology transfer because their staff serve a wide range of customers and thus able to transfer technology horizontally (between customers in different industries) and vertically (between research and development) including the unwritten part of the knowledge carried by the people involved.

The first recommendation of the Working Group on Innovation should be addressed by the establishment of a network of Faraday Centres which build on the strengths of the RTOs.

THE NEED FOR A HIGHER LEVEL OF STRATEGIC DIRECTION

The second recommendation of the Working Group on Innovation should be addressed by the establishment of an Industrial Research and Technology Council (IRTC). It should be independent of government and parallel to, and able to liaise with, the Advisory Board for the Research Councils for the better harmonisation of fundamental and applied research. Its responsibilities would include the identification of overall industrial research goals and strategy and the management and auditing of public funding, both targeted and untargeted, including funding of Faraday Centres and other companies and organisations.

Members of IRTC should be appointed by the Secretary of State for Trade and Industry, in consultation with the Secretary of State for Education, and should include Chief Executives of RTOs, representatives of large and small industry (including government departments with significant requirements for innovation as end user, such as defence), academics and senior civil servants concerned with science and technology policy.

I would be very willing to meet the Committee to build on the general principles outlined above and to put at its disposal the unique and very great experience which AIRTO member companies have accumulated in bringing about the transfer of science and technology across the gap between academia and manufacturing industry.

Memorandum submitted by the Manufacturing Science and Finance Union (30 September 1992)

1. MSF AND SCIENCE

Manufacturing Science and Finance (MSF) is a multi-industry union spanning the public and private sector with over 600,000 members. The union was formed as a result of a succession of mergers in the trade union movement. One of our predecessor unions was the Association of Scientific Workers (AScW) which was largely responsible for placing the general importance of science onto the agenda of the national trade union movement.

The AScW was part of the merger that formed the Association of Scientific, Technical and Managerial Staffs (ASTMS) in 1968. ASTMS continued developing policy in the area of science and worked with the Association of University Teachers (AUT) and Institute of Professional Civil Servants (IPCS) in the Alliance for Science.

ASTMS in turn merged with TASS in 1988 to form the MSF. The new union brings together scientific workers in universities and professional scientists and engineers in industry, we also have scientific membership in the National Health Service and Research Council field. Because MSF also has a large membership in the insurance sector we can bridge the gap between innovation, development, investment and marketing. With an estimated 120,000 members engaged in science, R&D and transferring innovation to marketable goods and services, MSF is organised in almost every area necessary to harness the next generation of scientific and technological advance.

2. INTRODUCTION

MSF welcomes the inquiry by the Science and Technology Committee into the future of S&T in the United Kingdom. We also note positive signs which are emanating from Government recognising the importance of science to the future of the UK and we hope that this marks a decisive break from past attitudes. Last year's real increase in the science budget and the recent establishment of the Office of Science and Technology (OST) has also been welcomed by MSF.

Whilst we understand that it does not fall within the remit of this inquiry we believe that past Government policy in this area at times has been mistaken and damaged our science base. We do not wish to go into detail here about our criticisms of past policy but believe that a summary of these would assist in placing in context our views expressed in the submission. A more detailed analysis of this country's science decline is contained within our pamphlet: "*Science for Britain*", which was published in March 1992.

The summary of our criticisms are as follows:

(a) The relative level of expenditure on science in the UK compares unfavourably with most other OECD countries.
(b) The UK spends a greater percentage of GDP on military R&D than most other OECD countries.
(c) The existence of a weak and diffuse government-backed infrastructure for the co-ordination and promotion of science in the UK.
(d) The weak links between research councils, higher education institutions and industry.
(e) The dominant influence of a philosophy in the City which results in the expectation of high returns in a short period, leading to an underestimation of the corporate value of R&D, normally known as "short-termism".
(f) The lack of adequate promotion of science in our schools and as a high status, well rewarded, career path to follow.

3. THE NEED FOR A STRATEGY

MSF shares some of the scepticism about purely structural solutions to the problems facing science at the moment. However, at present there is no overall co-ordination of science policy by a single minister. In addition no single department is responsible for research. The Department of Education and Science (DES) is responsible for the "science" budget. The Department of Trade and Industry (DTI) is responsible for technology and innovation. Other government departments are responsible for the applied research needs to assist in carrying out their executive functions.

Therefore what is referred to as science policy in the UK is in reality a collection of policies rather than a strategy. MSF believes that there should be a government strategy for R&D and innovation which ensures a co-ordinated and consistent policy across the private and public sectors.

Opponents of such a viewpoint have done so on the basis of opposition to "big government" and claim that it will lead to an intrusive interference into the affairs which should properly be the concern of the management of companies. Another criticism is that such approach will lead to government seeking to "pick winners". This is possibly a misinterpretation of the ideas of advocates of a science policy for the UK. There is a certain amount of economic determinism in the viewpoint that companies through the market will respond automatically and invest in R&D sufficiently to secure their companies future. Unfortunately this is not the case. Most companies are risk adverse. Also can it truly be said that what is good for the country in terms of R&D expenditure is the sum total of decisions reached by UK companies?

Other factors are at play in influencing company expenditure decisions which may be perceived as proper corporate governance but may not be in the best interest of the overall future of this country. For example, the current recession has resulted in worrying reductions in industry financed R&D expenditure in the UK.

The pressure for this action is coming from City institutions intent on maintaining profit levels (and dividend levels) throughout the recession. Many of our competitors' nations are still maintaining or increasing investment levels in this area.

A co-ordinated approach would seek to alleviate such pressures and offer incentives for the expansion of R&D efforts. This is not a recipe for underwriting inefficient companies but providing a material base for UK success in the upturn.

MSF is clear that it is not at this stage seeking a new Ministry to direct company policy in relation to R&D but instead a Government initiative to co-ordinate the efforts of the science community. A collaborative project between Government, research institutions and both sides of industry to assist in meeting the best needs of the country. Our objective is not to seek to build levers of intervention but devolop an organic relationship between the involved parties to assist in creating a science culture in the UK. Simply the distinction that we are seeking to make is between intervention and support.

We advocate in our pamphlet: "*Science for Britain*" the creation of a Council of Science and Technology, under the direction of the Minister, which will advise the Government and report directly to Cabinet.

We believe that such a body will ensure wider and informed participation in decision making. This will also replace existing bodies such as ACOST and the ABRC. The work of the ABRC could be undertaken by a committee of the Council and better review funding applications from individual research councils.

One final proposal contained within our pamphlet: "*Science for Britain*" is for the creation of an Office of Technology Assessment, based on the US model and answerable to Parliament. Reports from the OTA would seek to be analytical and neutral. They will offer options and evaluate the advantages and disadvantages of each argument. They will not produce recommendations but provide a service to Members of Parliament in order to improve scientific knowledge and as a result scientific debate in the two Houses. The Parliamentary Office of Science and Technology (POST) could be upgraded to fulfil this role. At present POST receives insufficient support from Government to effectively carry out such tasks.

4. Innovation and wealth creation

We believe that the Government could take more action to show that it has a commitment to innovation. It could start by devoting a higher proportion of public funds to innovation in manufacturing industry. In particular, the DTI budget for such matters should be restored to the real levels of the mid-1980's.

Another problem is that the DTI has been dogged by constant changes in the Secretary of State and repeated changes in political priorities. Many of these changes have more to do with form rather than content but the underlying move has been to roll back the frontiers of the state.

The DTI has been weakened and appears to lack any strategic sense of the importance to the country of certain industries, believing that its main role was creating the correct climate for enterprise. Indeed it was common currency amongst in government circles to extol that it was a part of a historical process for service industries to replace manufacturing industries, in the same way that these had supplemented a rural based economy. The DTI has resorted to exhorting industry to be more innovative rather than provide sufficient support. We would like to stress the central importance of the DTI playing a key role in ensuring that industry invests sufficiently in R&D in order to ensure the future economic well-being of the country.

The UK needs to produce marketable goods with which to trade to enjoy future prosperity. Manufactures are still responsible for the majority of our foreign export earnings.

Recent events give a stark indication of how the market views the perilous state of the UK economy. Much of the damage to the UK economy has been self-inflicted. Many commentators have deluded themselves that in some way this has resulted in economic reconstruction and what were mistakenly typified as our "old heavy industries" have disappeared. Past Government policy towards reducing inflation has caused real pain for our manufacturers and until recently high interest rates have resulted in a decline in industry financed R&D.

Perhaps now we can begin to address the weakness of the UK economy and the contribution of innovation to our future industrial success. MSF supports the concept of a single European currency and therefore supported membership of the Exchange Rate Mechanism (ERM). Although we doubted the wisdom of the level at which we entered. However the lesson to learn from the recent debacle is that the UK economy needs to be strengthened before we can consider re-entry.

If market forces alone are to determine the course of events than our manufacturing base will continue to be weakened. We agree with the view stated in the House of Lords Select Committee on Science and Technology report: "*Innovation in Manufacturing Industry*", that "Government has a legitimate role in identifying and promoting generic technologies and industrial sectors of key importance to the future."

We outlined in our previous section that we believe that industry alone does not generate sufficient innovation for the best benefit of the country. A fact that has been recognised by the DTI. Government has a role to play in providing support. Governments in competitor countries provide such support for the innovatory process in their own countries. In particular, this support should be directed at small and medium sized firms (SME's), which may have insufficient resources to effectively innovate, and may with appropriate support become our industrial leaders of tomorrow.

Another element of creating mechanisms for converting research results into wealth creating wealth technologies is the creation of appropriate regional structures. These development agencies would also be the appropriate bodies for the development of closer co-operation between research councils and higher education institutions with industry. We would like to highlight the relatively successful record of the national development agencies in Wales and Scotland. Other regions in the UK would benefit from the establishment of similar structures.

5. International collaboration

In relation to international collaborative programmes we believe that our viewpoint in relation to this has been well documented in Chapter eight of the House of Lords Select Committee on Science and Technology report: "*Innovation in Manufacturing Industry*". We do not seek to reinvent the wheel in this instance but believe that collaboration of this kind can be of major benefit to the UK. The cost of R&D for many national based EC companies is becoming prohibitive. However these companies need to undertake this R&D if they are to successfully compete with Japanese and US based ones.

The DTI needs to be more pro-active in identifying possible sources of EC funding for collaborative projects which may be of benefit to UK companies. Further it needs to provide support and guidance to companies, particularly to SMEs, on how that funding may be accessed.

We view seriously the accusations of many industrialists that the application procedure is too bureaucratic. In the short term the DTI has a role to play in assisting companies around what could be a byzantine maze in Brussels, in the medium to long term, the Minister for Science must forcefully lobby in the EC that the application procedure be made clearer and simplified.

It does unfortunately appear amongst our members in the science community in this country that the UK is a reluctant participant in such programmes. Whether this is a fair criticism could be better addressed by the UK Government developing complementary programmes to the EC initiatives.

On the contrary it appears that the Treasury attribute funds received from the EC to Government departments, whose funds are then reduced in the next public expenditure round. This is not only counter to the EC doctrine on receipt of such funds but hardly acts as an incentive to Government departments to access EC money. Our own standing with the EC is not improved by seeking to use EC money to reduce public expenditure instead of expanding scientific effort in the UK. We hope that the Minister would address these issues and become a forceful advocate for the UK's scientific interest in the EC.

6. Summary and conclusion

The scientific community in the UK needs stability and a strategic sense of direction for the future. The manifold changes in the DTI has not assisted innovation in the UK. The fluctuating attitude towards funding to meet short-term government macro-economic objectives has greatly damaged our science base and not assisted our Research Councils and HEIs to effectively plan programmes of research. In our view the total level of government and industry financed needs to be increased to match the level of our leading competitors. We also we need to develop a strategy between government and the social partners to take science and innovation in this country forward. We hope that you find our comments are of use in your deliberations and would be willing to expand on these if invited to participate in your inquiry.

Summary

We are seeking:

(i) A major increase in expenditure on civil R&D.

(ii) The development of a science strategy for the UK through the creation of a Council of Science and Technology which will incorporate the work of ACOST and the ABRC, and be under the direction of a Minister for Science.

(iii) Greater support from government for innovation in industry and the development of regional based structures to promote innovation and links between the science community and industry.

(iv) The upgrading of the Parliamentary Office of Science and Technology (POST) to undertake a role similar to the Office of Technology Assessment in the United States.

(v) Greater commitment and participation in European and other international collaborative research projects.

Letter to the Clerk of the Committee from the Royal Society of Chemistry (30 September 1992)

INTERIM SUBMISSION TO THE SELECT COMMITTEE

I am writing on behalf of The Royal Society of Chemistry to convey the Society's wish to contribute to the Select Committee's inquiry and deliberations into "the policy and organisation of the Office of Science and Technology".

The Society itself will be making a formal submission to the Government in the autumn—and will provide the Select Committee with a copy of this submission when it is available. However this is likely to be after the Select Committee's own deadline of 30 September.

In the circumstances, therefore, the attached submission from the Society represents only an interim view couched in general terms. The Society's full submission will touch in more detail on some of the questions which the Select Committee wishes to address.

Introduction

The Royal Society of Chemistry greatly welcomes the recent establishment of the House of Commons Select Committee on Science and Technology. The Society hopes that Science will thereby achieve a greater political profile within Parliament and a secure place on the agenda of regular Parliamentary activity.

The Royal Society of Chemistry wishes to contribute to the Select Committee's deliberations into the policy and organisation of the Office of Science and Technology.

The Society itself will be making a formal submission to the Government in the autumn—and will provide the Select Committee with a copy of this submission when it is available.

The Promotion of Science

The Society believes that one of the greatest challenges facing the Government—any Government—in the promotion of Science is the need to boost the public image and recognition of Science and scientists within the culture of today's modern society.

The Royal Society of Chemistry, although naturally concerned most of all with science policy affecting the discipline of chemistry, takes the view that the promotion of all Science is vital—wherever the exact boundaries may lie between one branch of Science and the next. Progress will be better if the Government seeks to work in partnership with the scientific community.

In today's competitive world the United Kingdom needs more than ever a settled, secure and healthy research environment in which significant national resources are devoted to basic research.

There also needs to be a greater awareness of the part that science research can and should play in today's global context—involving greater recognition of the need to develop cleaner technologies—and the contribution that science can make in progress towards sustainable development.

The Continuing Link Between Science and Education

The challenge of promoting Science must be faced in many areas—especially within the educational sector from the Nursery/Primary level upwards—and at the very time when (in Whitehall) **Science** has now become organisationally decoupled from **Education** the Government should not lose sight of the continuing and vital connection between the two.

The future wealth of the United Kingdom depends in no small part on the future provision of a population and a workforce that is numerate as well as literate and the adequate supply of those—whether working as scientists or researchers or teachers or in some other area—who have a real scientific understanding.

An Historic Opportunity

The events of the past few months—notably the creation of the post of Minister of Public Service and Science and the establishment of the Office of Science and Technology—offer an historic opportunity not seen in a generation for the re-evaluation of science and technology policy: both the way in which it is organised and the policies that should be followed.

The opportunity exists no less in the Parliamentary arena where the creation of the new Commons Select Committee on Science and Technology, and the decision of the House to provide a measure of Parliamentary funding for the Parliamentary Office of Science and Technology, offers a fresh start for close Parliamentary scrutiny of Science. The Society, for its part, will seek to assist the new Select Committee in any way possible to this end.

Memorandum submitted by Amersham International (30 September 1992)

1. We would like to make a brief response to the initiative of the Science and Technology committee enquiry into the policy and organisation of the office of Science and Technology. The main interest of the enquiry is concerned with government organisation for Science which is somewhat remote from our day-to-day management of a high technology company. Nevertheless we believe our experience is relevant and would like to make a contribution to the key questions:

"How can the process of turning research result into wealth creating technologies be improved?

2. Amersham International is a company which has experienced the whole range of types of ownership —from private company through Ministry of Defence, United Kingdom Atomic Energy Authority and (recently) privatisation to plc status. It was derived from exploitation of artificially produced radioactivity and hence its range of interests covered a very wide field of science from radiopharmaceuticals through life science research aids to clinical diagnostics and industrial process control products. To cover this range it has been essential to use ideas from third parties on an international scale; collaborations with academic research institutes and other industrial companies has been a way of life to us for many years. The success of our approach is indicated by five Queen's Awards for Technological Innovation, two of these being the direct outcome of collaborations, one with an NHS supported group in the UK and the other with a US university.

3. Innovation, whether product or system, is not a single event but a whole process. It begins with discovery (or invention) but moves on to cover analysis, feasibility, decision to adopt and implementation. The industrialist has to manage the whole process and cannot divorce himself from any part.

4. The commercial innovation of tomorrow is based on the basic research of today, and it is our belief that the appropriate place to go the basic research is our university system. The more support given to basic research now, the more likely it is commercial spin-offs will be generating profits in 10 years time. The funding of applied research (so-called "near market") to the detriment of basic research restricts enthusiasm and creativity and removes the pressure from industry to carry out the legitimate development work.

5. It is also our view that in 1992, there is not a major problem in industrial collaboration due to lack of ideas from academia or willingness to collaborate from industry. Almost every university campus has a system for dissemination of information; Oxford has its Innovation Society where we are happy to pay £5,000 a year for the privilege of access once a quarter for discussions with academic staff; Oakland have constructed their "Industrial File" which profiles both the status of academic departments and the particular requirements of individual industries. In some ways there is too much information. What we need is help in accessing that information, perhaps the DTI could consider constructing "road maps" to lead the small company to the most relevant source of information and sort options for the larger companies. It is not exhortation to collaborate we want but help to find the best contacts UK-wide. The "Faraday Centre" principle might help here in focusing academic links in major scientific areas, e.g., biotechnology, but this does not appear to be an intention of such organisations.

6. In our view the main issue becomes the lack of innovation management in the UK, and this is where government help and training would be invaluable. Exploitation of technical idea demands most of the following requirements from companies:

(i) Finding the right source of ideas.
(ii) Being prepared for collaborations—you cannot simply "buy-in" expertise, there must be sufficient understanding in the company to access and direct it.
(iii) The collaborative link must not be short-term, the best adaptor can be the inventor. You cannot "grab a technology and run away".
(iv) It is vital to get strategic directions on both sides understood at the outset. "Hidden agendas" ruin a technology transfer, sharing a common vision is rewarding.
(v) Competencies need to be checked—otherwise surprises come years later at advance development stages (e.g., "I thought these guys could manufacture, or market!—or whatever").
(vi) The key legal and intellectual property aspects need to be agreed at the outset and totally understood. This may seem overly business like but it is vitally important.
(vii) "Styles" need to be understood and differences appreciated—like levels of decision making, meeting culture, etc.
(viii) Trust is essential—not a concept that many companies use in searching for innovative development.

7. The management of this whole process should be amenable to analysis, case-history collections and training (both directly and by information dissemination). It is the method that needs improvement, not just encouragement to try.

8. Of course there are a variety of general issues which need addressing but which are perhaps more correctly directed to the collection of evidence for the White Paper on Science and Technology. These include:

(i) The supply of science graduates. The recent drive in companies to increase efficiency has disguised the crucial need for graduates in chemistry, physics, and the biological sciences. This will get to crisis proportions in a few years time.

(ii) Educational standards are slipping in basic science with lower and lower standards being accepted for university entrances. Industry will be fighting over a small number of good prospects.

(iii) The complexity of UK grant systems deters all but the most determined and organised (usually the large companies whose need may well not be the greatest).

(iv) Product licensing in the health care sector in the UK is (again) unhelpful to the small developer.

9. A final issue is that of co-ordination of scientific effort in the UK. Part of the problem complicated access to ideas mentioned about is that there is much more competition and duplication in research in the UK that can be optimal. A notion worth considering is that of the Canadian "Centers of Excellence" which link academic groups in particular areas of scientific research over the nation in co-ordinated programmes which recognise and manage the contribution of each group. This has to be government organised and sponsored—but the output in the UK could be truly remarkable as well as being a stimulating exercise to those involved.

Memorandum submitted by the British Medical Association (2 October 1992)

The British Medical Association welcomes the establishment of the new Office of Science and Technology with cabinet status for Science. In particular it welcomes the inquiry into the manner in which to construct the work. There is a need for a stronger mechanism for integrating scientific and technological research and for taking an overview of research actioned through the various funding councils. There are several key points the British Medical Association wishes to make:

(1) A number of universities have set up enterprise groups to effect the translation of research results into wealth creating technologies. There is a need for a Government group that will underwrite industry in translating research results into industrial activities. It is felt that the DTI should take the prime role in encouraging and underwriting this translation.

(2) In some respects the current bodies, such as the Advisory Council on Science and Technology (ACOST), the Advisory Board for the Reasearch Councils (ABRC) and the funding councils, are appropriate. However, whilst it is recognised that these bodies need a co-ordinating group which would decide upon priorities, this is outside the existing bodies' capabilities.

(3) It is felt that in an area of such importance the Minister should take the lead role in the Office of Science and Technology.

(4) The Chief Scientific Adviser should be a senior co-ordinator and Chairman of the overview group and should have the role of developing objectives of research of prime national interest. He should also be responsible for overseeing involvement in European issues.

(5) There needs to be a group under ministerial direction which would identify problems and, with the Chief Scientific Adviser, work to develop plans to resolve these problems.

(6) The Minister as a member of the Council of Science Ministers in Brussels should ensure that the views of British Scientists are communicated within the European Community. He should also ensure that British Scientists are actively involved in European collaborative programmes. Finally, it is important that, when available, European funding is appropriately used in science projects.

Letter to the Clerk of the Committee from Michael Rouse, Managing Director of WRc PLC (2 October 1992)

SCIENCE AND TECHNOLOGY INQUIRY

I respond to the request issued via the Press Notice to provide input into the inquiry by the Committee.

The response made directly to the Office of Science and Technology answers the particular questions which were raised by that office rather than those set out in the Press Notice. Nevertheless, I hope that the thoughts will be of value to the Science and Technology Committee.

APPENDIX

Letter to Professor W Stewart, FRS, Chief Scientific Adviser, Office of Science and Technology, Cabinet Office, 70 Whitehall, London SW1A 2AS (21 September 1992)

SCIENCE AND TECHNOLOGY—CONSULTATION

I refer to the letter to our Dr John Moss dated 22 July 1992, from the Cabinet Office inviting our organisation's views on the way forward in relation to the exploitation of science and the application of technology.

In preparing our views we have attempted to focus our reply on the specific questions posed by the Minister, as follows:

Why does the UK seem to be less successful than its competitors in translating inventions to the market place?

In general, short-term business thinking drives decisions in most industries. There is little incentive to take risks for the medium/long-term benefit of businesses, when the performance of the company is gauged by relatively short-term financial yardsticks. As a nation we are perceived to lag behind certain nations in relation to the management skills necessary to identify and translate inventions into business benefits. There is a possible contrast between UK industrial R&D and that of certain other EC and EFTA countries, where UK work is often seen to be problem-driven around existing products rather than in the identification of novel and new product opportunities.

From our experience, there appears to be a lack of objective information to provide a definitive answer to the question.

Why is this more so in some industries than others?

There is no simple answer capable of generalisation. Key influencing factors are market forces, management calibre, company culture and possibly size.

In some industries it is crucial to innovate in order to survive. The fashion and music industries are extreme examples of where the manufacturing capability exists to support an echelon of creative talent. Another extreme example is Formula One racing, which is focused on clear, simple and precise goals with ruthless competition. An additional example of success is the pharmaceutical industry, where R&D, including safety testing, is crucial. This is a low volume, high value products industrial sector.

In other industries the potential for innovation to provide clear business benefit is less clear. It tends to be one of many factors in business decision-making to achieve or maintain business advantage. Factors such as reducing manufacturing costs, attention to quality, improving cash flow, etc., tend to form the common language of the business manager. In this context, innovation and its role can easily get lost. However it is interesting that innovation can be applied to all aspects of business life.

The construction sector is a good example of a major industry where, in general, there is lack of innovation. The reasons are complex but relate to factors such as:

(1) Technical standards often maintain the "status quo" rather than permit innovative products meeting end user requirements.
(2) Fragmentation of the industry into a web of complex business relationships.
(3) Relatively low managerial and technical skills due to its lack of attractiveness in a professional career sense.
(4) A dominance of short-term financial thinking at the expense of visionary medium and long-term opportunities.

*Do we have an agreed measure of the capacity of an industry, or a firm, to innovate?**

No.

Do we really know whether our firms are getting better or worse at innovation?

No.

Do technology-based innovative firms survive longer?

Cannot be truly answered unless * is answered. There again appears to be a lack of objective information. Our perception is that innovative firms are often in the high risk, high return category, but may rate low in the survival stakes.

The above three questions should perhaps be considered from the viewpoint that innovation in itself is not a route to business success or failure. Businesses respond to markets and customer needs and succeed if this can be achieved in a sustainable and profitable manner. In some markets, innovation is a key to success, in others less so. Customers do not generally buy products because they are innovative.

Is the alleged lack of innovation a lack of good ideas, or finance, or what?

We would subscribe to the view that there is no shortage of good ideas or innovative talent. The missing key ingredient is that despite much effort, the effectiveness of transferring innovation into the market place and the matching up of ideas with finance is patchy. We appear to be weak at picking the "winners" and matching innovation with market opportunity/need.

Do we need more or less planning in Government science and technology?

The role of the Government needs to be transparent and clearly defined. It has a key role to play in setting broad goals and gaining the commitment of the financial and business community from a national standpoint. In certain areas of fundamental and strategic research it is probable that Government can be the only provider of financial support. Government has a clear role in taking a lead in these areas. It also has a right to expect a complementary commitment from industry, and the financial sector to play its part. A degree of planning is therefore essential, but not in a detailed day-to-day sense. More effort should perhaps be expended on implementing and assessing the benefits of research. Current effort tends to focus disproportionately on the proposal stage. There is a danger of stifling innovation by failure to acknowledge the risk of failure, and in only funding work where the outcome is known at the proposal stage.

There is a clear need to identify areas of national "strategic" importance and to focus curiosity-driven research in these "strategic" theme areas.

Do we get optimum benefit from our international collaborative programmes, especially in the European Community, and do they complement our national programme well?

No. We need to increase the UK share of EC funded research. There is scope for improved integration between UK and European activity. It is interesting that, for instance, the Fraunhofer Institutes in Germany receive national funding in addition to EC funding for EC contract research. The "single market" for research is not yet a reality.

Annex 1 contains an extract from the Fraunhofer Annual Report for 1990, which gives further background.

Does the UK get the very best value for money from Government's considerable expenditure on science and technology?

There is scope for continuous improvement. In particular the balance between research, development and implementation activities and funding requires continuous review.

Are spending priorities right or would the Government be better advised to spend money in other areas of science and technology than the ones it funds at present?

It is important to recognise that research is resource constrained, and to focus R&D spend in areas of strategic importance. From our viewpoint it is not possible to comment objectively. However, technology to address environmental problems (cleaner and clean-up technology) could offer significant national benefit, with export potential). The construction industry is also important to the economy and may benefit from specific and significant initiatives. An increasing emphasis at a European level will be the operation and maintenance of existing infrastructure.

Government has a key role to play at the national and European level in the setting of technical legislation and standards. The area is crucial, since it can either stifle innovation or enable it to flourish. New or changed standards can enable the introduction of new technologies which can provide a competitive edge. Please see AIRTO Policy Paper 92/3 attached.[1] Government and industry can work in partnership to exploit opportunities for national benefit. The Germans provide a good role model for this activity. The drafting of sound legislation and standards requires a strong R&D base, and this is particularly important in order to negotiate from strength at a European level.

Does the Government have the right advisory structures at its centre to help it take decisions on priorities?

There is a need for greater clarity and transparency in the working of current advisory structures and the communication of their activities. The interface between the Research Funding Councils and DTi is of particular importance in this context.

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[1] Not printed.

Perhaps the division between science and engineering is a little sharp and there is a need to look more closely at how fundamental science can support industry in the medium/long term scenario.

How can we best ensure that the strong upward trend in industrial R&D expenditure in the UK will continue and gather pace in the years to come, so that our record is as good as the best of our international competitors?

By recognising and promoting the benefits of R&D. By highlighting these benefits in both a financial and a technical sense. Too often the technical benefits of innovation are promoted without an adequate dissemination of the business aspects. By improving the training of managers involved in implementing change and exploiting the results of innovation. By improved recognition by the financial community of the relevance and importance of industrial R&D to business success. Buying technologies and know-how by acquisition can offer short-term solutions to the purchaser but it needs to be balanced by market incentives to undertake R&D.

Could the links between academia and industry be improved to encourage maximum exploitation of the science base?

Yes. The recently announced partnership betweeen Independent Research Organisations (IRO's) and Universities (HEI's) under the auspices of DTi, are one such example. These pilots need to be developed into a more significant initiative. Flow of talented people between Government, academia and industry could be a key platform to future success.**

Is the UK working in areas of basic science which have less marketable derivates than those on which our international competitors concentrate their efforts?

Unable to provide objective comment. Our general perception is "yes".

Is there scope for improved training opportunities in science and technology?

Yes. See ** above. The problem of employers lacking the incentive to train staff in a competitive market place needs to be addressed. For example, in the construction industry individual UK employers have little incentive to train staff and quality suffers. In France and Germany the existence of formal guarantees for up to 10 years provides a business incentive in the market place to improve quality.

What steps do we need to take to improve the status of scientists and engineers?

An echelon of scientists and engineers who are role models in society needs to evolve. The skills of engineers and scientists should be recognised and respected in a wider community. We should reach a situation where our top scientists and engineers are recognised and discussed with peers such as Richard Branson, Lord King, Mark Weinberg, Nigel Kennedy and Peter Hall! This can only come from a combination of circumstances as diverse as public recognition, remuneration, training, opportunity, etc.

There needs to be a more flexible interchange between scientists and engineers in academia, industry and the Civil Service.

A final additional point is that perhaps we are suffering from a plethora of initiatives, all starting from good intentions but modestly funded. An alternative would be for less initiatives in broad strategic areas, with more substantial funding.

A key observation I would wish to note from our deliberations on the questions is that there appears to be a distinct lack of objective information in certain key question areas. It may be that policy development could be supported by some specific studies in certain strategic areas.

Please do not hesitate to contact me further if you require any additional background. I trust that our contribution can play a small part in formulating a sound policy for publication in a White Paper of key national importance.

ANNEX A

Excerpt from Fraunhofer Annual Report 1990

Basic financing inadequate

Given this situation, it would appear to be an opportune moment for the Fraunhofer institutes to reorientate their focus towards the EC research programme. Unfortunately, the financial situation precludes this option.

Unlike other research institutes the FhG receives 30 per cent basic financing for its contract research. Capital expenditures also have to be financed from these funds. This means that there is much less than the 30 per cent basic financing for the company's own research and to cover the risks of the institutes. The EC encourages joint European research on the principle of cost sharing and only puts up 50 per cent of the funding itself. In addition to the higher preliminary costs because of the greater specific co-ordination requirements, the FhG must ensure the co-financing of half the costs. In the case of research and development in the "Acute Technological Development" sector, co-financing by industry is possible to a certain extent. Half of the funding for R&D projects from the other two sectors would have to come from the basic financing. It is not the purpose of these funds to provide this financing, nor is there a sufficient amount available in them. In order to safeguard its international competitiveness the FhG considers intensified participation in the joint European research to be essential; it has therefore approached its financiers, namely the Federal Government and the Länder, to help it overcome this specific obstacle.

Letter to the Clerk of the Committee from the Council of Science and Technology Institutes (5 October 1992)

EVIDENCE TO THE HOUSE OF COMMONS SCIENCE AND TECHNOLOGY COMMITTEE

The Council of Science and Technology Institutes (CSTI) is pleased to respond to the invitation to submit evidence to the Science and Technology Committee for its Inquiry into the policy and organisation of the Office of Science and Technology.

CSTI represents the collective views of the major professional science bodies concerned with both basic and applied science and technology. Several of our constituent members will be submitting individual evidence to you directly.

As you know, the Rt Hon William Waldegrave, Chancellor of the Duchy of Lancaster, has invited all sectors of the community to submit views to the Office of Science and Technology in order to contribute to the development of a White Paper on the organisation and future of science and technology in the UK and the Government's role in it. CSTI will be submitting its views to the OST in the near future and I will send you a copy as soon as it is available. The following summarises some of the points that we will be making that relate to the OST.

We warmly welcome the establishment of the OST and the assignment to a Minister in the Cabinet of overall responsibility for science and technology. Representation of science and technology in the Cabinet will have a beneficial influence on the decision making process and, in turn, will influence the prospects for improving the national economy and, indeed, there is the potential for enhancing the future of society on this planet. The whole scientific community is encouraged by these developments.

While welcoming the formation of the OST, we are concerned that science policy should not be artificially divided between existing bodies and newly created organisations.There must be a coherent policy throughout Government and the nation for the organisation, and the pursuit and application of science. Strong and effective links must be maintained between OST and other Government Departments, especially the Department for Education where, for example, we see a need for retaining a dual support system so that university departments can support talented young research scientists as a complementary mechanism to seeking support from Research Councils.

Again, commonality of interest between the Department of Trade and Industry and OST must be recognised and links maintained. Without a profitable manufacturing industry, national prosperity is threatened. There is, therefore, a requirement for an effective framework that will include incentives to encourage investment in research and development and its exploitation, thus capitalising on our national scientific ability.

A major concern today is the negative attitude of children and their parents towards science.The OST must, in collaboration with the DFE and Employment Department, address this critical issue, since it is the schools and institutions of further and higher education that will be providing the educated and trained scientific workforce required to implement the nation's future policy on science and technology.

In summary, the OST's remit and function should not be constrained but it should actively collaborate in the formulation of policy with other appropriate departments—principally those concerned with science teaching, initial and continuing training, research, technology, engineering development and manufacturing—as well as independent scientific bodies. An example of such collaboration is the project, jointly funded by CSTI and the Employment Department, for mapping the science domain: details are given in the enclosed News Release.[1]

CSTI urges the registration of professionals, both at the Chartered scientist level and by means of registers in specialist fields where the public interest is of paramount importance (e.g., environment and health care). This requires support and encouragement from government. The public is protected by such registers and they are complementary to the aims of the Citizens' Charter.

Although the pursuit and application of science must be largely commercially driven, we argue that there are important areas of scientific pursuit that are directed to provide under-pinning base-line information and not a specific commercial product. We believe, therefore, that public money should be available for the collection and collation of data on such areas as the environment (atmospheric, physical and geological) ands taxonomy of living species.

Finally we would like to remind the Chancellor of the Duchy of Lancaster, and his advisers, that decisions taken on the future policy and organisation of science and technology in the UK must be long-term decisions and that the scientific community will hope for a period of stability and consistency. If policy and organisations are subject to continual revision, all the hard thinking and decision-making will have been in vain: the pay-back on investment in science and technology is not achieved in the short term.

CSTI hopes that the House of Commons Committee will find these comments useful. We will be pleased to assist the Committee in the future.

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[1] Not printed.

Memorandum submitted by the Ministry of Defence (8 October 1992)

Q1: A BRIEF DESCRIPTION OF THE RANGE OF RESEARCH AND DEVELOPMENT PROGRAMMES FUNDED BY THE MINISTRY OF DEFENCE

1. The research and development programmes of the MoD are to enable the needs of the Armed Services for equipment and weapons to be met in a timely and cost effective manner. The research programme enables the Ministry to act as an intelligent customer for such equipment. It is aimed at sustaining an underlying foundation of scientific and technological expertise on the basis of which support can be given to the selection, development, production and operation of weapon systems and equipment, and assessments can be made of the likely future evolution of the threat and options for countering it. In contrast development is directly related to the procurement of specific military equipment and its subsequent enhancement, and is the essential precursor to the production of such equipment.

2. The research programme is undertaken in Ministry of Defence (MOD) establishments, principally in the Defence Research Agency (DRA), and as funded research in industry, research institutions, universities and other institutes of higher education. Overall, the research programme is characterised as applied research, i.e., work directed primarily towards equipment projects 5-10 years ahead; and strategic research, i.e., innovative long-term research aimed at the acquisition of new scientific and technological knowledge for future defence exploitation. Technologies covered include: acoustic, electromagnetic and electro-optic sensing; aerodynamics and hydrodynamics; chemical and biological defence; electronic devices and components; energetic materials; warheads and propulsion; guidance, control and navigation; human factors; nuclear sciences; signal and information processing and computing; and structures and material sciences.

3. Applied research, valued in cash terms at some £400 million per annum, consists mainly of work packages focused on specific military functions such as underwater surveillance; battlefield target acquisition; offensive counter air; and strategic command and control. Strategic research programme, costing some £47 million per annum, is relevant to defence in the longer term, even though its precise application may not yet be clear.

4. Development programmes bring to the production stage projects which meet the equipment needs of the Armed Services. Before a new development programme is embarked upon, however, careful consideration is given to equipments already available off the shelf, to the scope for collaboration with allied nations and to the possibility of upgrading existing equipment. Last year some £2,030 million was spent on development of particular equipments. Of this, the bulk (some £1,530 million worth) of project development was carried out in industry.

5. Current or recently completed major development programmes include:

Sea Systems:	Vertical Launch Seawolf Missile System Spearfish heavyweight torpedo.
Land Systems:	High Velocity Missile AS90—155mm Self-propelled Howitzer
Air Systems:	Harrier GR7

Q.2: HOW RESEARCH PRIORITIES ARE CURRENTLY ESTABLISHED AND HOW THIS MAY BE AFFECTED BY THE ESTABLISHING OF THE OFFICE OF SCIENCE AND TECHNOLOGY

6. The research programme is formulated on the basis of an assessment of future threats and of the operational requirements needed to implement UK defence policy. A further relevant factor is the manner in which new and emerging technologies might develop and how they might be exploited for defence purposes.

7. A key element is ensuring that resources are devoted only to those areas for which there is a real requirement is the establishment of a strong customer/supplier relationship between the MoD and its research suppliers. This is exemplified by the work that is currently in progress to turn the DRA into a Trading Fund, currently planned for 1 April 1993, where customers will hold the funds for research and buy this and advice and expertise from the Agency.

8. The Applied Research Programme is under the control of the Ministry's Deputy Chief of Defence Staff (Systems) and the Strategic Research Programme under that of the Deputy Chief Scientific Adviser. The research programme is kept under regular review to ensure that value for money is being achieved and that the needs of the Armed Services are being met.

9. Overall responsibility for ensuring an adequate balance within the MoD non-nuclear research programme rests with the Defence Research Committee chaired by the Ministry's Chief Scientific Adviser. Independent advice is provided by the Defence Scientific Advisory Council, the membership of which includes the Government's Chief Scientific Adviser, and the Chief Engineer and Scientist, DTI.

10. In order to assess the balance of technology more systematically within the research programme, MOD has recently initiated a series of rolling reviews of specific areas of technology. It is the intention to review each area every four years. This analysis will assist the development of a UK list of "generic technologies", an initiative led by the OST and DTI, in which MOD is participating.

The role of the OST in relation to MOD is covered in para 15 below.

Q.3: IF THE MINISTRY EVER TAKES A VIEW THAT SOME PROJECTS IT MIGHT FUND ARE MORE APPROPRIATELY FUNDED THROUGH THE RESEARCH COUNCILS, AND, IF SO, WHAT CRITERIA GOVERN THAT DECISION.

11. It can happen that high quality unsolicited research proposals put to MoD may not attract MoD support because they are of insufficient relevance to the MoD research programme. However, the Joint Research Council/MoD Grant Scheme was established in 1985 to promote interaction between the MoD research establishments and the Science Base supported by the Research Councils. Through this scheme, the MoD can contribute up to 50 per cent of an award made by a Research Council. The criteria for MoD support are potential defence relevance and benefit to the defence programme. Currently, some 300 grants are being supported by MoD at an estimated cost of about £5 million in 1992-93. The MoD and DRA staff also serve on SERC Committees.

12. The MoD makes use of research facilities and capabilities in institutions of higher education (HEIs) through defence research contracts and agreements placed by the Defence Research Agency and other MoD establishments. Currently, MoD is funding some 780 contracts and agreement at a total value of some £75 million.

13. Both the DRA and CBDE place work with HEIs where they have the appropriate skills and expertise required to take forward the research programme. In deciding which HEIs to approach, account is taken of the advice of the Defence Scientific Advisory Council.

Q4: HOW THE MINISTRY OF DEFENCE CO-ORDINATES ITS RESEARCH AND DEVELOPMENT ACTIVITIES WITH THOSE OF OTHER DEPARTMENTS AT PRESENT, AND WHAT MEASURES ARE TAKEN TO ENCOURAGE THE TRANSFER OF TECHNOLOGY FROM MILITARY TO CIVIL USE.

Co-ordination

14. Regular discussion takes place between MOD and other government departments, both through inter-departmental committees and bilaterally. For example, there is a regular contact between MOD and the Air Task Force of the DTI who are an important customer of aerospace research at the Defence Research Agency. MOD is also a member of the inter-agency committee for Marine Science and Technology.

15. In common with other Government Departments having significant S&T interests, the MOD has close links with OST, principally through formal committees, but also in more informal ways. The generic technology work mentioned in paragraph 10 above is one example of where OST is identifying areas of common interest to promote collaboration between Departments and to ensure that maximum benefit is derived from Government funded research activities.

Transfer of Technology

16. Although defence research is conducted in pursuit of defence objectives, MOD recognises that some of this work may have civil application. The DRA undertakes work for the DTI, some of it as part of MOD/DTI jointly funded programmes, and for the Civil Aviation Authority and the European Community. An independent study, conducted some years ago by an outside body, of the civil use of defence technology developed by MOD contractors, found that in 40 defence contractors some £3 billion of civil sales per annum were built on defence generated technology. It would not, however, be a proper use of defence funds to employ these contractors in the exploitation of defence technology in products for the civil market.

17. A wide range of initiatives has been taken to encourage interaction between the two sectors. These include joint funding with industry of technology demonstrators, participation in research "clubs" with private firms to pursue research of common interest, e.g., vehicle electronics, remote sensing; and participation in LINK. In addition, the outcome of defence work is published in open literature, wherever possible, and defence scientists participate in the activities of learned societies.

18. The Civil Industrial Access Scheme (CIAS) was launched by MoD and DTI in 1988. This was to acquaint the private sector with the expertise and facilities in the defence research establishments, including access to test facilities, collaborative research and specialist technical consultancy. Currently, work of a value of some £22 million per annum is done by the DRA for private sector customers. The CIAS concept has now been subsumed into the DRA which is required under its Framework Document to exploit and pursue commercial outlets for the DRA's services insofar as this makes use of intellecutal and physical capabilities required for defence (and other government departments') purposes but not fully utilised.

19. Within the DRA, the Commercial Directorate is specifically concerned with identifying and pursuing business opportunities for exploiting the Agency's intellectual property rights. Where commercial exploitation opportunities arise which cannot be adequately exploited by the DRA itself, outside agencies or consultants are engaged to take this forward on a non-exclusive basis.

20. In its role as the MoD's prime supplier of technical advice, DRA is developing a process of strategic alignment with major defence companies. Its purpose is to ensure that research is well targeted, that industry is motivated and able to exploit DRA's research in its planned products, and that the DRA for its part can make maximum use of industry's research in supporting MoD.

Letter and Memorandum from the Institute of Professionals, Managers and Specialists (7 October 1992)

Please find attached the evidence from the IPMS to the House of Commons Science and Technology Committee Inquiry into the Policy and Organisation of the Office of Science and Technology.

We have tried to stick to the questions asked and to take account of recent developments but the document which IPMS published in November 1991 "Science in Crisis: a Trade Union Response" and to which we refer in our evidence contains much of the background detail. I am therefore enclosing a copy of that publication in case it is of assistance to you. We also refer in the evidence to an IPMS submission to the House of Lord Science and Technology Committee's inquiry into the Faraday Programme. This is also enclosed. Further copies of both these documents can be supplied on request.

Submission to the House of Commons Science and Technology Committee on the policy and organisation of the Office of Science and Technology

Introduction

1. The Institution of Professionals, Managers and Specialists (IPMS) is the trade union which represents 90,000 scientific, technical and specialist staff in the civil service, related public bodies and an increasing number of private sector companies.

2. IPMS members can be found in a variety of activities covering the full spectrum of research from "basic" to "near market". Their work ranges from developing more effective weaponry for defence to finding the new products to protect our food supply from contamination or disease. IPMS members set standards for industry and offer advice and guidance to companies. They inspect, monitor and research into the environment, health and safety at work, energy conservation, medicines and forensic science. IPMS also represents the specialist staff in the Patent Office and in the British Technology Group.

3. Members of IPMS have been seriously and adversely affected by reduced funding and rapid changes in science and technology policy which characterised the 1980s. In central government the number of scientists has fallen by 35 per cent since the late 1970s; a deeper cut than that suffered by the civil service as a whole over the same period. Savage cuts have also taken place in the research councils. For example, in the Agriculture Research Council scientific staff have been cut by 30 per cent between 1984 and 1990 and the vast majority of new appointees are on short-term contracts. IPMS has compaigned on the specific areas affected and for recognition of the importance of science and technology and the reflection of this in the pay and status of scientists and technologists and in November 1991 published "*Science in Crisis: a Trade Union Response*".

4. A key part of the IPMS programme for science and technology, published in that report, called for the "strategic co-ordination of UK science and technology policy at national and international levels, led by a dedicated Minister within the Cabinet". IPMS therefore welcomes the appointment of a Cabinet Minister who has overall responsibility for the co-ordination of science policy within government, and presenting science at the UK and international levels.

5. IPMS also argued for many years that the issues of science and technology policy needed a much higher profile in Parliament and a much wider understanding among MPs. We therefore also welcome the decision of the House of Commons to establish a Science and Technology Committee and the decision to establish the Parliamentary Office of Science and Technology on a firmer financial footing.

6. Science and technology have never been more vital to our future—in education, in improving the environment, in the management of ever more complex societies, and in the quest for sustainable economic growth. Yet in the senior ranks of the government service there are still very few people with science and technology backgrounds and they are almost never to be found in areas outside the purely scientific and technical.

7. The appointment of William Waldegrave, the establishment of the Office of Science and Technology and the appointment of the House of Commons Science and Technology Committee give grounds for hope that the climate for science and technology in the UK might change for the better but much more work remains to be done.

How can the process of turning research into wealth creating technologies be improved? What might be the respective roles of OST and DTI in this?

8. If economies are to be successful they need the research, innovation and development of new technologies to be combined with the application of those new techniques. The UK's historic lead in many areas of scientific and technical research has been lost through the reluctance of both the public and private sectors to invest in the ideas.

9. Even where advances have been made their commercial development and application have often taken place overseas. There, a combination of strong governmental involvement in directing technology policy and public and private sector investment in R&D have resulted in stronger economic growth.

10. In the UK neither the private nor public sectors have invested adequately in R&D and successive governments have failed to adopt a clear national policy towards science and technology. This weakness has been exacerbated by uncertainty about the aims and activities of the DTI.

Role of OST

11. A national strategy for the UK needs to be spearheaded by the Minister for Science and the OST; aided by the national science and technology advisory bodies, in consultation with research bodies, industry and trade unions. Such a strategy should:

- Identify key fields for investigation and development backed by executive support in all departments and agencies.
- Monitor all government backed R&D schemes to ensure that funding is correctly targeted and R&D properly managed.
- Maintain and develop an adequate UK science and technology infrastructure.

12. It is also vital to boost science within the government machine. The role of the Minister, Chief Scientific Adviser and OST with strong scientific and technical support at the centre need to be matched by a strong senior scientist organisation in departments and agencies. More scientists are also needed in the general policy making ranks of government. The role of the OST under the Chief Scientific Adviser is to give a strong lead to science within all areas of government in addition to providing policy advice and support to the Minister in Cabinet and in the EEC.

Role of DTI

13. The DTI should play the major facilitating role in supporting innovation and its conversion into wealth creation. Its capacity to do so however has been severely damaged. Since its foundation the DTI has been dogged by repeated restructuring and changes in political priorities and personnel. The DTI should be the government's main vehicle to support industrial R&D. Instead the rapid switches of policy and its non-interventionist stance have resulted in a decline in staffing, funding, and effectiveness.

14. Total R&D spending by the Department is due to fall from an estimated £241 million in 1991-92 to a planned £199 million in 1993-94 and £211 million in 1994-95. While spending on industrial innovation is set to rise by around 14 per cent, in real terms, from an estimated £82 million in 1991-92 to £104 million in 1994-95, this still does not match the funding level of 1987, even in cash terms. In addition, funding for technology transfer, an area of admitted weakness in the UK economy, will fall from £92 million in 1991-92 to £86 million 1994-95, a decline in real terms of almost 17 per cent.

15. PA Consulting Group, in advice to the House of Lords Science and Technology Committee, argued that the government had to take the lead on R&D activity since it plays a major part in the innovative activity of the nation. PA argued that the government via the DTI should actively participate in the generation, finance and performance of R&D by:

- Providing a regulatory framework to safeguard consumers and control the application of technology.
- Providing financial support for research that is vital to the "technology push" elements of innovation.
- Organising and promoting collaborative ventures between firms.

IPMS would endorse this approach.

Role of other organisations and initiatives

16. Although the DTI should take the lead in industrial innovation and technology transfer other departments, agencies, and organisations have a role to play and their respective contributions should be strategically assessed by the OST and the Minister. MAFF, for example, has a responsibility for the agriculture, food and fishing industries, and their abrupt withdrawal of funds from "near market" research had as damaging an impact on the agriculture sector, particularly small and medium sized enterprises, as that same policy did in the DTI context.

17. The role of military R&D also needs to be taken into account in any strategic approach to technology transfer an the identification of emerging and generic technologies. ACOST in its report "Defence R&D: A National Resource" and the POST review paper on "Future Relations between Defence and Civil Science and Technology" both recognised the role which military R&D could play in underpinning civil technology by developing generic technologies of use to both civil and military sectors and stimulating civil exploitation of defence technologies.

18. The establishment of the Defence Research Agency should give a new opportunity to develop wider integration and spin off to the rest of the R&D community. One of its specific objectives is to meet the requirements of other public or private sector customers and to support the government's overall environmental objectives. It should be given the encouragement and resources to develop this role. At the moment, whoever, it is reeling under defence expenditure cuts which are undermining its capacity to fulfil

either its core defence remit or the broader role envisaged by POST and ACOST. In the process a highly skilled scientific and technical workforce is being laid off with no strategy or mechanism for their effective redeployment.

19. The latest proposal to improve technology transfer is the establishment of Faraday Centres. The aim is to improve the flow of people, and so ideas and concepts, between HEIs and industry. The Centres would be located within "Intermediate Institutes" such as industrial research associations, government and research council laboratories. While IPMS accepts the need to improve technology transfer we are not wholly convinced that Faraday Centres will achieve the objectives set for them.

20. Since IPMS has members in many of the "intermediate institutes" to which CEST suggests attaching the Faraday Centres we have given written evidence to the House of Lords Science and Technology Committee inquiry into the issue. We stress in that evidence that if Faraday Centres are to be launched there must be adequate "new money" for their support, not a diversion of funds from other sources; and they should proceed cautiously with a few pilot studies which would need to be fully evaluated before the next wave of centres was launched.

21. A more immediate and effective way of improving technology transfer would be to allow government and research council laboratories to resume "near market" research. This would enable them to range across the full spectrum of research from "basic" to "near market" and to perform their valuable bridging link between HEIs and industry.

Intellectual Property Rights

22. The important role of IPR in technology transfer has been highlighted in the recent first report of the OST on "Intellectual Property in the Public Sector Research Base". The report shows that although large public and private organisations have the internal resources to manage the IPR dimension smaller public research organisations, especially HEIs, and small- and medium-sized enterprises (SMEs) in the private sector lack the inhouse expertise.

23. The report mentions the role of the Patent Office and the British Technology Group in encouraging knowledge of IPR processes and helping organisations to use the system. As the report also points out, however, the privatisation of BTG is likely to reduce the attention paid to the needs of HEIs and other public sector research organisations, or to the needs of SMES, as it proceeds to concentrate on larger projects with a significant rate of return.

24. IPMS and many others warned that the privatisation of BTG would jeopardise its long-term, "patient money" approach, forcing it to focus on short-term profits. Indeed, so great were the disadvantages of privatisation that even the government's own advisers, Coopers and Lybrand, recommended that BTG should be kept in the public sector. BTGs first annual report after privatisation confirms those fears. For, in addition to reporting a loss, it shows that BTG is concentrating on big projects, particularly from outside the UK.

25. The British Technology Group, recognised as the world's leading technology transfer organisation, should have a key role in promoting the adoption by industrial companies of technologies developed in the public sector. However, if as now seems likely it is unable to perform this role adequately in its privatised form it should either be returned to the public sector so that it can resume its vital role in encouraging innovation and technology transfer or an alternative public agency which can do so should be created.

RECOMMENDATIONS

(i) A national strategy for the UK should be developed by the Minister for Science in consultation with research bodies, industry and trade unions.

(ii) The Office of Science and Technology and the Chief Scientific Adviser have a key role to play in supporting that strategy and in ensuring that the role of science and technology in all government departments is strengthened and co-ordinated.

(iii) The DTI should take a leading role in supporting innovation and its conversion into wealth creation in particular it should:

  Stimulate innovation and technology transfer and expand support for regional technology centres.
  Give government and other research bodies more help to adapt to the EEC single market.
  Retain industrial research agencies within DTI as a source of in-house expertise and resource for projects with industry.
  Serve as an access point to public sector databases for engineering, scientific and marketing information.
  Encourage the City and industry to take a longer term view of investing in R&D.

(iv) The Defence Research Agency should be helped to play a broader role in civil R&D.

(v) An end to the artificial distinction between basic and "near market" research in the allocation of government funds and public funding for organisation which provide the bridging role between basic research and near market development.

(vi) The British Technology Group should be returned to the public sector so it can exploit public R&D with the private sector.
(vii) The innovatory role of the UK Patents Office should be strengthened.

What structure does the government need to advise it on science policy? Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate?

26. Advice to government on its science policy comes from a variety of sources both within and outside the public sector. The structures of both need to be considered.

External Advice

27. Although the new government structure of a Minister for Science and Office of Science and Technology should strengthen our ability to generate and implement science and technology policies both within the UK and in Europe there is still a major requirement for a body able to advise the Minister and (either through him or directly) the Prime Minister on the Science and Technology aspects of strategic policy issues of national importance and transcending the boundaries of individual departments, companies or research agencies. It should be a body, like ACOST, which has senior representatives from all sectors of the economy engaged in science and technology based activity and which can take an independent and comprehensive overview of the needs for science and technology from the basic to "near market"; can expose gaps and duplication; and evaluate the degree of "additionality" "subsidiarity" and specialisation which is required at the interface between the UK, the EEC and the rest of the world.

28. In addition to this broad overview role there will need to be some changes to the role of ABRC and the other advisory bodies which represent the various areas which contribute to the science and technology infrastructure. There needs to be a body which can co-ordinate and represent the interests of the public sector "science base" whether this be in universities, research councils or other fringe bodies. The IPMS has no specific form of organisation to suggest but would make two general points about any such reorganisation.

29. Firstly, there should not be too rigid a demarcation between customers, contractors and policy advisers. Policy must continue to be informed by those who are actually working in research organisations in the relevant areas as well as by "outside" or independent advisers and customers. It is also important that there should be flexibility for individuals and organisations to follow hunches in pursuing research topics. A body like the ABRC but possibly broader in scope would still be required to advise on the broad strategy and funding for basic and strategic research and to assess the appropriate balance between "responsive" and "directed" research. The chairperson of such a body should continue to be a member of ACOST or its replacement.

30. While such changes to the ABRC's role might require a loosening of its relationship with the individual research councils as "contractors" the IPMS would be very concerned if it was suggested that the research councils should be reabsorbed into their sponsoring departments. The separation has been of benefit to both. The research councils have used their independence to undertake first rate research and publish the results, some highly critical of government policy. Departments have benefited from having researchers available to undertake work whose independence cannot be impugned. The danger of re-absorbing the research councils is that departments may attempt to interfere with both the selection of research projects and the publication of the results, if these do not meet the political objectives of the moment.

Internal Policy Making and Advice

31. The internal government policy-making and advisory structure must also be strengthened. While OST and the Minister for Science will have a co-ordinating role, this needs to be matched by a strong senior scientist organisation in departments and agencies and by a strengthening of scientific expertise throughout "Whitehall".

32. The Senior Open Structure (Grade 3 and above) statistics for January 1992 show that there are still relatively few scientists and technologists in senior policy making positions whether specificially in the science and technology area or more generally. Of the 20 permanent secretaries in charge of civil service departments none are from the scientist ranks and only two have specialist or professional background of any kind. Of departments with substantial numbers of scientists in employment only the MoD has more than a sprinkling in their senior ranks and many have none apart from the chief scientist. For example, in the Department of Environment, a highly technical and crucial policy area, out of 45 staff in the top three grades only two are scientists; one is the Chief Scientist and the other is the Chief Executive of the Building Research Agency. In the old Department of Energy, again a crucial and highly technical area, there were no scientists or technologists and only one specialist of any kind out of 15 senior staff.

33. In the Department of Trade and Industry there are seven scientists out of 65 senior staff. Of these two are chief scientists and three are executives of research agencies. In MAFF there were three scientists out of 37 senior staff; two were chief scientists and one was chief executive of the Central Science Laboratory. In the Scottish Office which has a large number of scientific research establishments there were no scientists out of the 35 staff in Grade 3 and above and very few specialists of any kind.

34. In the Department of Education and Science there was only one scientist, Sir David Phillips, Chairman of the ABRC, among the 21 staff at Grade 3 and above. Even the Chief Scientific Adviser within the Cabinet Office works in splendid isolation with no scientists at Grade 3 or above in the Cabinet Office.

35. It is vital that there should be a flow of high calibre scientists and technologists into senior policy making positions because of the increasingly technical complexity of many political and administrative decisions. Also with the increased trend in university, research council and government research establishments towards competition for contracts, encouraged by UK Government policy and the impact of EEC public procurement directives, it is essential that the "customers" in government departments should be well equipped to make a fair and scientifically informed selection from among the "contractor" bids.

36. There are three main sources from which such "scientifically literate" senior policy makers can come; from more junior scientists and technologists within government, through external appointments, and through the generalist fast stream entry. Each currently have their problems.

37. Although external specialist direct recruits at senior levels have a role to play, many are likely to be unfamiliar with the Whitehall machine and are no substitute for scientifically expert insiders. There is also a problem in obtaining high quality entrants because of the continuing and growing disparity in salaries and conditions between the different employment sectors, particularly between the public and private sectors.

38. There are still relatively few direct "fast stream" entrants to senior policy making positions who have scientific or technical qualifications. In 1990-91 only 17 per cent of Administration Trainee or HEO(D) (the "fast stream" entrance route for senior policy making positions in the civil service) passing the final selection board were science or technology graduates. This is the same percentage as 1985.

39. The most effective source and one which would also enhance the career prospects and status of scientists in government research would be to encourage greater movement of practising scientists already in the civil service into senior policy making positions. Lip service is paid to this objective, not least by the Head of the Civil Service, Sir Robin Butler. However, other policies within the civil service for which the Minister for Science, wearing his other "hat" as Minister for the Public Service, is ultimately responsible, are pulling in the opposite direction. There is a growing remoteness between research agencies and their parent departments in terms of accountability, policy making, and staffing. This is likely to reduce even further the flow of high calibre scientists and technologists into policy making positions. For example in DTI the responsibility for promotion and career development for Unified Grade 7 (the crucial bottom rung of the unified grades and route into the senior management structure) scientists will in future lie solely with each research agency, whereas "generalist" administrators at UG7 in agencies will continue to be tied into the department wide promotion and career development structures.

40. Well over 50 per cent of government scientists are now in agencies. If the senior policy making grades within government are to be "scientifically literate" then there must be mobility within and between departments, agencies and other public research providers (research councils and universities). The fragmentation of the career structure, breaking the links between departments and agencies, and devolved pay arrangements will reduce even further the flow of high calibre scientists and technologists into senior policy making positions within government departments.

41. The Minister and Chief Scientific Adviser must take a serious look at the impact of these government policies on their responsibilities in relation to science in the public service. These policies militate heavily against the creation of a strong scientific influence within the government machine.

RECOMMENDATIONS

(i) There is a continuing need for an advisory body which can take place an independent and comprehensive overview of the science and technology needs of the UK and their interface with the EEC and the rest of the world.
(ii) There should not be too rigid a demarcation between customers, contractors and policy advisers. Policy must continue to be informed by those who are actually working on research as well as by outside or independent "advisers" and "customers".
(iii) A body is still required to advise on the board strategy and funding for basic and strategic research and to assess the appropriate balance between "responsive" and " directed" research.
(iv) The research councils should remain independent of their sponsoring departments.
(v) More scientists and technologists are needed in senior policy making teams. The role of government chief scientists should be enhanced to improve high level policy input and co-ordinate research.
(vi) The Government policy of separating departments and agencies, fragmenting career structures and devolving pay arrangements should be reversed.

"Is it appropriate for the effective Chairman of ACOST to continue to be an industrialist with a technological background, or should the Minister take the lead?

42. IPMS believes that as important as who chairs its meetings is the question of the membership of the Council.

43. The terms of reference of the Council are to advise the government on: priorities for science and technology; the application of science and technology; the co-ordination of science and technology activities; and, the nature and extent of participation in international collaborations.

44. The exclusively male membership of ACOST is drawn almost equally from the worlds of industry and academia, together with the chairmen of the UFC and ABRC. It can not be possibly argued that there are no suitably qualified women who could not add to the deliberations of the Council. In addition, the Council has no members drawn from consumer or environmental groups, reseach organisations or trade unions. If the government is to receive relevant and balanced views on the direction of science policy the membership of the Council must be drawn from a wider cross section of the scientific community.

45. The chairmanship of the Council is effectively held by an industrialist, although the Prime Minister has chaired some of its meetings. Since the role of the Council is to provide government with a source of independent advice on a range science and technology policy issues it would be inappropriate for it to be chaired by the individual charged with developing the government's overall strategy. For this reason IPMS would oppose the installation of the Minister for Science as chairman of ACOST.

RECOMMENDATIONS

(i) The membership of ACOST should be broadened.
(ii) The chair of the Council should be drawn from among its members and not be a Minister of the Crown.

"Can any problems which arose from the previous ways in which science policy was co-ordinated be identified?"

46. The organisation of publicly funded research and development, with its plethora of funding and performing bodies was "co-ordinated" by a series of interdepartmental committees serviced by the Cabinet Office. The system resulted in many problems of which three are of particular significance:

— Resources/funding.
— Co-ordination, nationally and internationally.
— Secrecy.

Resources/Funding

47. With no single minister responsible for ensuring that R&D received a fair share of government spending, it has been squeezed under pressure from competing activities. While in cash terms public spending has risen and is planned to continue to rise, in real terms it has fallen. Between 1985-86 and 1990-91 spending in real terms fell by 15 per cent. At 1990-91 prices, spending fell from £5.858 billion to £4.962 billion and will continue to fall to £4.793.6 billion in 1994-95. And this may prove to be an overestimate given the pressure on public expenditure in the next few years.

48. The most severe decline is in spending by civil departments. Between 1985-86 and 1990-91 spending, in real terms, fell from £1.397 billion to £1.086 billion, a 22 per cent fall. Spending is planned to fall to £0.880 billion in 1994-95. Even if non-departmental civil R&D spending is included, the decline between 1985-86 and 1990-91 was 7.9 per cent and the fall between 1985-86 and 1994-95 will be 10.7 per cent.

49. In comparison with the other leading EC countries the UK has a poor record of civil R&D spending. In 1990 in the UK government funded civil R&D amounted to just 0.51 per cent of GDP. In Germany, France and Italy the respective percentages were 0.9; 0.85; and, 0.7 per cent. In addition, the proportion of GDP spent on civil R&D had declined from 0.63 per cent in 1985.

50. While proportions in Germany and France have also fallen the rate of decline is lower. The fall in the UK is 19 per cent while in Germany and France it is 11.8 per cent and 14 per cent. Given the respective states of the four economies, it is also worth noting that of total government funded R&D the UK spent 9.6 per cent on industrial development. In Germany, France and Italy the percentages were 12.5; 11.9 and 16.7 respectively.

Co-ordination

51. It was only following the prompting of the House of Lords that ACOST agreed to publish a three-yearly strategic review of British science and technology. This was indicative of the lack of planning and co-ordination at senior levels within government. It has resulted in a failure to exploit emergent technologies and to take a full role in the negotiation and execution of international scientific programmes.

52. As mentioned earlier, successful economies are characterised by governments which have set out their long-term strategy for science and technology. The lack of such policy in the UK has resulted in the frequent policy reversals which have been evident over decades under the administrations of both major political parties.

Secrecy

53. Decisions on the allocation of funds and research priorities should be open and the information on which they are made should be made public. The failure to publish the advice received from the ABRC was a flagrant recent example of the suppression of information which a government minister has found to be politically expedient.

54. The new minister's belated disclosure of those reports to the "Independent" is welcome and we hope that this will be followed by publication of the 1992 ABRC advice at a time which enables debate to influence decisions and not retrospectively when it is purely a matter of historical record.

RECOMMENDATIONS

(i) Government funding of civil R&D should be raised to a level similar to our major EC partners —0.9 per cent of GDP.
(ii) More co-ordination is required to ensure that research objectives are met, programmes are consistent and strategic gaps are filled.
(iii) Information on funding and options for research priorities should be made public. Scientific and technical information should be open to Parliament and public unless there are compelling national security constraints.

"Are there any areas which experience particular problems such as, for example, UK participation in international collaborative programmes?"

55. Research and development is increasingly taking place at an international level. This is not only in the traditional areas of "big science", where large facilities need to be jointly funded. As scientific endeavour seeks to understand and resolve world issues such as global warming and poverty in the "Third World", more and more R&D programmes are becoming collaborative efforts. Finally, the European Community (EC) is increasingly a focus for R&D activity, most notably through its Framework Programme.

56. Involvement in international scientific programmes (ISPs) has obvious advantages. For the UK as a whole, it offers influence over the direction of research programmes, prestige, and the pooling of scientific data, expertise, and, of course, funding. For the individual scientist, it offers the opportunity to participate in programmes which are often, by their very nature, at the "leading edge". There are also wider contacts and new insights to be gained from international liaison.

57. Continued participation in ISPs is vital to the long term health of the UK science base. But the weakness of the science base is undermining the UK's historically high level participation in such projects. The Commons Committee on Education, Science and Arts pointed out that a research community starved of funds, inadequately equipped and short of permanent, qualified scientists is unlikely to continue to be seen as an attractive partner. More recently, the Lords Select Committee on Science and Technology, in its report on ISPs, supported this view, adding that, in the long term, the differences between UK and overseas scientific salaries will exacerbate the situation.

58. The UK government should be taking a more positive role in promoting and supporting UK science and technology internationally. It should also adopt a more positive attitude towards hosting international projects and facilities in the UK.

59. There are however, three areas of particular concern with the way that internatinal collaboration effects UK science:
— Pay and status of UK scientists.
— Funding.
— Setting priorities.

Pay and status of UK scientists

60. The problems of our own members at the Joint European Torus (JET) project at the Culham Laboratory illustrate the problems which need to be resolved and the gap which now exists between the poor status and pay of scientists in the UK and those in Europe and elsewhere. Some of the workers at JET are employed directly by EURATOM and others are seconded from and still employed by AEA Technology. The EURATOM staff working closely side by side on the same project and doing similar work are in some cases paid twice as much as their AEA counterparts and have superior career opportunities.

61. A recent survey for the EEC by four independent consultants on terms and conditions at nine of the European Communities' joint reseach projects, including JET, has made a number of recommendations which could help resolve some of the issues but a solution is being delayed by "buck passing" within the EEC. So far the UK government has insisted that the JET problem is for the AEA to solve, yet some of the EEC resources which might be used to help fund a solution are remitted direct to the Treasury and not passed on to AEA.

62. Clearly the employment status and terms and conditions of scientists working on EEC and international programmes need to be clarified and established on a basis of equity if international projects are to flourish.

Funding

63. The Treasury employs an accounting practice which acts as a considerable disincentive to involvement in ISPs generally and EC programmes in particular. Under the system of "attribution" the Treasury insists that funds received through EC R&D programmes are attributed to the budgets of one or more spending departments. Those department's budgets are adjusted downwards in the following annual public expenditure round to take account of these extra receipts.

64. "Attribution" undermines the EC principle of "additionality", which is enshrined in Community law. This requires that any funds received through an EC programme should be additional to a nation's public expenditure and not used to subsidise underfunding by that nation of a particular area of expenditure. If any "excess" income that a department or public body derives from participation in EC programmes is clawed back by the government, that can only harm science.

65. Successive reports form both Houses of Parliament have criticised the Treasury's use of the "attribution" system. In July 1990 the Lords Select Committee on the European Communities commented that "the system operates against the national interest and the needs of industry as it only makes worse the under funding of R&D in the United Kingdom."

66. The Commons Education, Science and Arts Committee in December 1990 called "upon the departments concerned to demonstrate that the principle of additionality, enshrined in Community law, is not being breached and that funds obtained by UK research institutions from EC R&D programmes are genuinely 'new money' and are not clawed back by the Treasury from spending departments." The response had been a deafening silence.

67. The House of Lords Select Committee Inquiry into Systematic Biology Research also drew attention to the current Treasury policy on additionality and attribution and pointed out that some relaxation of the Treasury rules were required otherwise UK systematic biology research would be severely disadvantaged. Such comments are particularly important given the inter-governmental commitment to the preservation of and research on biodiversity at the environment conference in Rio.

68. IPMS members have also expressed concern over the Treasury's failure to allow for exchange-rate fluctuations and inflation differences. As a result, Research Council budgets are placed under strain from pressures over which they have no control.

69. An associated problem is that of complex bidding and management structures. A number of members have complained at the length and complexity of the process of tendering for work under EC programmes. This is often a function of the scale of the programmes under consideration. There is a tendency to favour very large programmes in order to simplify the administrative load in Brussels. The political desire on the part of the Commission to have a mix of "rich" and "poor" countries involved in these large programmes also creates managements structures which are often complex and bureaucratic. Time, effort and money is unnecessarily wasted on programme management which could be better spent on research.

Setting Priorities

70. The effect of "attribution" is to cut back the research funding by departments by the amount received through the ISP. In the words of the Commons Committee on Education, Science and Arts there is "a danger that research priorities in this country will be distorted, as EC funds for EC priority projects replace UK funds for UK priority projects."

71. In its evidence to the Lords Select Committee on Science and Technology, SERC outlined the growing tension caused by its exclusion from the EC R&D decision making process while at the same time being made responsible for the funding:

> "Although the Research Councils in recent years have been more active in influencing the content of EC R&D programmes, such programmes are ultimately decided at political level—in the EC Council of Ministers—in which political considerations inevitably play a role. The cost of such programmes is however borne indirectly via attribution to the appropriate Whitehall Department even though that Department was not represented at ministerial level at the relevant Council. To date the Science Budget has not been significantly affected by attribution, but this will come with the new Framework programme. The net effect will therefore be that the Science Budget, and the Research Councils will be obliged in the end to pay for international research programmes over whose level and content they have no direct control."

RECOMMENDATIONS

(i) The government must adopt a more proactive approach to international science activity in general and the hosting of projects and large facilities in particular.
(ii) The system of "attribution" as currently practised must be abolished.
(iii) UK staff engaged on ISPs should be employed on the same terms and conditions of employment as their international colleagues and the position of the "employer" in relation to such staff should be clarified.

(iv) Effective system should be created for disseminating information on ISP proposals, criteria and timetables; and for supporting researchers formulating proposals, including assistance with costing.

"What should be the objectives of the Minister as a member of the Council of Science Ministers in Brussels?"

72. Participation in international scientific programmes (ISPs) is essential for the long-term health of the UK science base. As mentioned earlier, the EC is increasingly the focus for R&D activity, most particularly through the Framework Programme.

73. We welcome the fact that the UK will now be represented in the council of Science Ministers by a Minister of Cabinet rank which should increase the UK's influence on science and technology issues within the community. In addition to achieving the objectives set out in the previous section the primary objectives of the Minister should be:

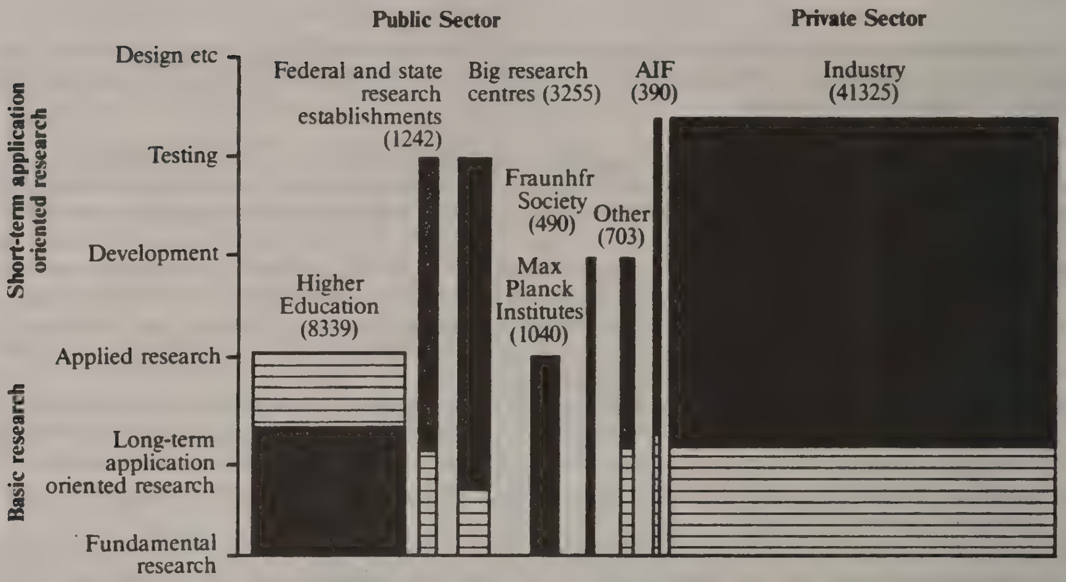
(i) To ensure that EC programmes provide "added value" to UK scientific programmes and are aimed at collaboration, networking and joint projects which can be best achieved at that level.
(ii) That there are evaluation systems to ensure that programmes are efficient and effective in achieving their objectives and that UK scientists are involved in the formulation of EC programmes and not simply in their evaluation.
(iii) That in addition to emphasising the importance of generic technologies, there should be recognition of the role near market research can play in the technology transfer process. Just as too rigid a distinction between "near market" and basic/strategic research has been damaging to public research and development in the UK so care should be taken not to make the same mistakes at the EEC level.
(iv) The public procurement directive could enable UK research organisations to bid for work across the community. However, if this is not to lead to severe damage to the UK science base such competition must be fair. The Minister must ensure a "level playing field" so that UK public research organisations are not forced to put contracts out to tender in among member states when research organisation, particulary in France and Germany are not.

RECOMMENDATIONS

(i) The Minister should assist in seeking out opportunities and supporting UK science.
(ii) EEC research programmes should provide **added value** to what can be achieved nationally.
(iii) EEC projects should provide a balanced programme ranging across the spectrum of basic to "near market" according to the social, environmental and economic needs identified by the community.
(iv) There should be fair and transparant process in the allocation of research contracts.

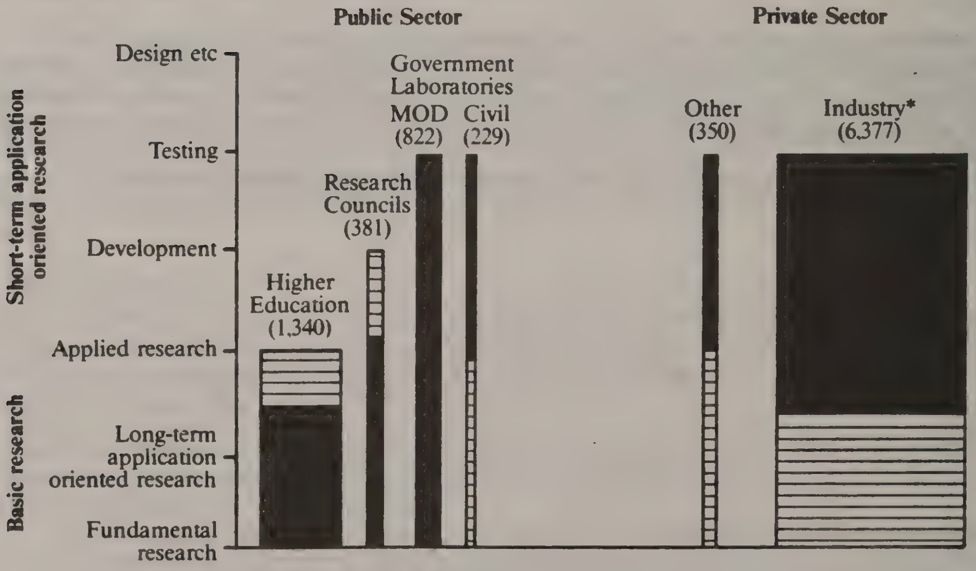
Research Expenditures in Germany and the United Kingdom

FRG Research Expenditure 1987 (DM mio)



Sources: Meyer-Krahmer. ISI: BMFT 1990. Tables VI13 & VI120; SERC 1990 vol. 2

UK Research Expenditure 1987 (£m)



* Includes £400m of R&D performed by the UKAEA and ~ £300 by AIRTO

Sources: Annual Review of R&D. 1987; SERC 1990 vol. 2

■ Major area of performance

▤ Minor area of performance

Bar area is proportional to R&D expenditure.

Fig. 7.12 The Performers of Research in Germany and the UK

Memorandum submitted by MAFF (8 October 1992)

THE RANGE OF RESEARCH AND DEVELOPMENT PROGRAMMES

MAFF is a science based department whose responsibilities could not be discharged without sound data, technical expertise and scientific innovation. R&D plays an essential role in formulation, appraisal and evaluation of many of its policies and in the practical application of these policies to the agriculture, horticulture, fisheries and food industries. MAFF's policies are increasingly concerned with consumer protection, public safety, environmental concerns and animal health and welfare. The supporting R&D programmes are substantially directed toward these areas. MAFF also supports strategic research which is essential to underpin the future commercial development of new technologies, processes and products, where the nature of the market is such that industries cannot fund the R&D themselves. The range of the research and development programmes funded by MAFF is therefore wide, reflecting the breadth of its policy concerns.

In 1992-93 MAFF is spending around £124 million on R&D. The programme can be broken down broadly into four themes consistent with the Ministry's aims. These are:

Protecting the public.
Enhancing the rural and marine environment.
Promoting a fair and competitive economy.
Protecting farm animals.

It should be noted, however, that some research programmes have multiple objectives, making classification difficult. This is particularly true of work relating to the environment. Under the above classification expenditure on work of a purely environmental nature would amount to around £19 million. However information relevant to the environment is also obtained from work classified under other headings. For example, minimising the use of pesticides and examining alternative systems of farming appear under the headings of protecting the public and promoting a fair and competitive economy. On this basis, the total expenditure on environmentally relevant work is closer to £50 million.

Protecting the Public

Work in this area spans four subjects, the safety of food, the nutritional quality of food, animal diseases which are relevant to human health and the safety of chemicals used in agriculture. In financial terms, the last of these is the largest, amounting to around £23 million in 1992-93. Work ranges from the development of methods for the determination of residues in animals slaughtered for human consumption to reducing the use and environmental effects of pesticides.

The safety of food constitutes the next largest area of expenditure (approximately £14 million). Here, research is concerned with the chemical, radiological and hygienic aspects of food safety. Examples include the development of tests, techniques and methods for analysing chemical and microbiological contaminants of food, assessing risk and obtaining a better measure of the levels of intake of additives. In the case of micro-organisms, MAFF is developing a unique database and expert system to predict the growth and inhibition of the principal pathogenic micro-organisms found in food. This will enable legislators and the food industry to assess the risk of the growth of micro-organisms in new food formulations, processing and handling conditions. In the area of food hygiene, work ranges from the rapid identification of viruses in shell fish, and obtaining a better understanding of viral uptake to the reduction of the contamination of carcasses in slaughterhouses.

Work on animal diseases is concerned with obtaining better control of those diseases in farm animals which have relevance to human health. Research is being undertaken particularly on tuberculosis, brucellosis, salmonella and BSE. The latter forms the largest part of the expenditure, amounting to around £5 million in 1992-93. The research is aimed at providing sound, scientific information on which to base recommendations to control the diseases and protect human health.

Around £5 million is also being spent on food quality and nutrition. MAFF has a responsibility to provide consumers with sound nutritional advice and part of the research is aimed at getting a better understanding of the role of nutrients in the development of disease and to improve the scientific basis on which to make recommendations on diet.

MAFF is also concerned with reducing the risk to life and property posed by river and coastal flooding. The aim of its research in this area is to promote effective and economic means of flood protection, flood warning and coastal erosion control which have due regard for conservation of the environment. Important areas of work include the accurate prediction of events giving rise to coastal or river flooding, improving the construction materials and the methods used in river improvement and coastal defence schemes and the improvement or maintenance of desirable habitats during their construction.

Enhancing the Rural and Marine Environment

A large part of the expenditure on the terrestrial environment is concerned with providing a sound scientific basis for the implementation of the EC Nitrate Directive. The work covers nitrate leaching from different types of agricultural land and crops and considers the effects of different husbandry systems. A predictive model of nitrate leaching from agricultural soils is being developed to try to reduce the need for expensive, field research and to give greater efficiency in the application and evaluation of control measures.

Work aimed at reducing environmental pollution is also important. The pollutants being investigated include silage effluent, slurry and animal wastes, contaminants of sewage sludge, odour and agricultural noise emissions. Agriculture is a significant producer of the greenhouse gases methane and nitrous oxide and £0.8 million is being spent on a programme of work on climate change. An important component of this is the identification of ways of limiting emissions of these gases.

The policy of reducing agricultural support for production and the encouragement of more environmentally sensitive farming practices has heightened the need for knowledge to improve the guidance that can be given to farmers on best management practices. MAFF's conservation programme includes consideration of the impact of farming practices on heather moorland, the effects of land drainage on animals and plants, the protection of species rich grasslands, the management of conservation areas in field boundaries and bracken encroachment.

Research totalling £3.6 million underpins MAFF's statutory and policy responsibility for regulating the discharge of radioactive and non-radioactive wastes to the marine environment. There is increasing pressure from the international environmental lobby to restrict sea disposal of waste and other forms of exploitation of the marine environment. MAFF's research programme ensures that the advice to Ministers is based upon sound scientific understanding so as to avoid imposing unnecessary restrictions and costs on UK operations. The work is aimed at obtaining a better understanding of the impact of wastes, including pesticides, on the aquatic environment.

Promoting a Fair and Competitive Economy

Two themes permeate the work funded in this area. The first is to provide strategic research to underpin those technological advances which will enable UK agriculture and food industries to remain competitive. The second is to ensure that environmental considerations are an integral part of these developments. Work on these themes spans all agricultural and horticultural commodities and includes research into fishery stocks.

In the horticulture and arable sectors, examples include the identification of improved strategies for the control of plant pathogens, pests and weeds, improvements in breeding lines and overcoming the variability in crop growth by identifying the nature of interactions between crops and their environment. MAFF recognises the contribution which organic farming can make to reducing fertiliser and pesticide use and is funding research in this area. It is also sporting a LINK programme on "Sustainable Agriculture".

Genetics, reproduction and nutrition are prominent features in the livestock research programme. Examples of strategic research include the physiological regulation of ovulation in cattle, the modelling of the effects of forage based diets on the components of milk, quantification of the factors which limit silage and forage intake, the identification of genes which influence conformational characteristics, embryo transfer in sheep and the breeding of genetically superior animals.

Research totalling £3.2 million underpins MAFF's policy responsibilities under the EC Common Fisheries Policy for the regulation of Sea Fisheries. Many stocks are seriously over-fished, yet our understanding of the biological and other factors which regulate fish stock size is relatively poor. Discards of immature fish are often high, adding to the problem. Improvement in the models and data used for stock assessment and prediction, together with studies of gear selectivity, aimed at developing appropriate EC conservation measures are the main thrusts.

MAFF is encouraging the industry to increase its own funding of R&D by supporting the LINK scheme. This has been highly successful in the food sector where MAFF co-sponsors two programmes: Food Processing Sciences and Agro Food Quality. The former aims to encourage strategic developments in new processes, biotechnology and process modelling and control, the latter to improve the consistency of raw materials and to develop an understanding of what determines consumers' perception of quality.

Protecting Farm Animals

Nearly £9 million is being spent on the prevention and control of animal disease which, in addition to its importance in protecting animal health, also helps to maintain UK competitiveness. Much of this work is concerned with the development of diagnostic methods, investigating methods of disease transmission, the epidemiology of disease, the development of appropriate techniques for the detection of viruses and the mechanisms involved in resistance and immunity to infection.

In addition to the work on farm animals, some work is being supported on the diagnosis of fish disease. This enables MAFF to discharge its statutory responsibilities more effectively and to ensure the continuance of the UK's high fish health status within the European Community's single market.

In pursuance of MAFF's policy of encouraging high welfare standards, it is funding work in three main areas:

— Improving housing systems, e.g., group housing systems for lactating sows, improvements in the design of cages for laying hens and alternative housing systems, safer livestock buildings.
— Studying the physiology and behaviour of farm animals during pre-slaughter handling, stunning and slaughter to appraise current practices and to develop and improve methods.
— Studies on poultry behaviour to better understand the scientific basis of pain, fear and stress.

THE ESTABLISHMENT OF RESEARCH PRIORITIES

The preceeding paragraphs demonstrate how MAFF's R&D priorities are determined by policy requirements. MAFF's R&D budget is divided between the Policy Groups, each of which decides on its own research requirements. The Policy groups are assisted in their decisions by expert opinion from both within and outside MAFF particularly on strategic research. Internally, this is provided by the Ministry's Chief Scientific Adviser and a group of scientific advisers within three Chief Scientist Groups, covering agriculture/horticulture, food and fisheries. MAFF scientists themselves draw on a wealth of information from a wide range of sources by keeping abreast of scientific advance and technological development throughout the world, and by working in collaboration with other government departments and funding organisations, particularly AFRC, SOAFD, WOAD and DANI.

Assistance is also provided by independent advice from a number of expert bodies. These include the Priorities Board for Agricultural and Food Research, whose terms of reference are to advise the UK Agriculture Ministers and the Chairman of the Agricultural and Food Research Council on priorities for research and development in agriculture and food and on the allocation of their research and development budgets. To ensure that there is adequate co-ordination of private and publically funded R&D, the Priorities Board is supported by six advisory sectoral groups which bring together the different sponsors of agriculture and food R&D. Other advisory bodies include the Food Advisory Committee on the Microbiological Safety of Food and the Advisory Committee on Pesticides.

The important role of the new office of Science and Technology will be to maintain a strategic overview of resources devoted to Government R&D. Where research priorities are largely policy driven, as in MAFF, it will continue to be necessary for these to be decided by the responsible Department so that the Minister directly concerned is answerable for the scientific underpinning of policy. The OST will clearly need to advise Ministers collectively on allocation of funds to sustain the science base. The OST should also have an important role in activities which cross departmental boundaries and which have an international dimension. In particular, there is a need to ensure that the UK has a co-ordinated and effective voice in discussions in the Community on the development and control of R&D spending.

THE CO-ORDINATION OF MAFF'S RESEARCH AND DEVELOPMENT ACTIVITIES WITH THOSE OF OTHER DEPARTMENTS AND THE AFRC

The setting of priorities and the co-ordination of activities are inextricably linked. MAFF works closely with other government departments and the research councils. MAFF is represented on the Council of AFRC and NERC, and on several of their working groups and committees. MAFF and AFRC, together with SOAFD are sponsors of the Priorities Board and other relevant government departmental representatives are included on their working groups.

Letter to the Clerk of the Committee from the Women's Engineering Society (9 October 1992)

INQUIRY IN TO THE POLICY AND ORGANISATION OF THE OFFICE OF SCIENCE AND TECHNOLOGY

We have seen your press notice on the above Inquiry, and have the following comment to make.

At this stage in the consultation we wish to express our concern that whatever policy and organisational provisions are made they must ensure that the concerns, priorities and interests of women are addressed equally with those of the male half of society. Women constitute half the recipients, of beneficiaries, or scientific and technological developments, are major contributors to the funding of scientific work through the taxation system, and should have equal opportunity for involvement and influence at all levels in science, technology and engineering. Women must therefore be equally represented on any decision making body in the Office of Science and Technology and special provision must be made to monitor the precise nature of expenditure on Science and Technology to ensure that the scientific community, with Government support, is benefiting the whole population.

I apologise that this offering is a little late, but I hope it will be of use to you.

Memorandum submitted by the Food and Drink Federation (16 October 1992)

INTRODUCTION

The Food and Drink Federation is the representative body of the UK food and drink manufacturing industry. It is the umbrella organisation for 50 sectoral trade associations, covering both large and small companies. FDF has, for a number of years, identified those cross-sectoral research priorities of prime importance to the whole food and drink industry and, on this basis, commented on the appropriate organisation and funding of public sector food research. A copy of the FDF's most recent report in this respect, "Food Research for the UK" accompanies this memorandum.

The future policies of the Office of Science and Technology will be a major factor in determining the future of the UK publicly-funded research programme and, presumably, the part which food-related research has in that. It is, therefore, a matter of considerable interest to FDF which is preparing to respond to Mr Waldegrave's invitation to make input to the White Paper on Science and Technology expected early in 1993.

GENERAL COMMENTS

Research in the Food and Drink Industry

Throughout Europe, consumers demand and receive, unprecedented quality, variety and convenience in their food supplies. Ever higher standards of wholesomeness are set, driven by science's ability to identify and chart potential benefits and hazards to health in what we eat. Throughout Europe also, in the increasingly international market, technological strength in production efficiency, quality and product innovation has become a crucial element of successful competition.

To meet these challenges, the UK food and drink industry devotes a substantial proportion of the added value it generates to research and technological innovation. Total UK research expenditure by food sector companies is large and growing. It was estimated by FDF in 1991 to be approximately £200 million per annum, of which about 5 per cent is spent with public sector institutions and around 5 per cent collaboratively in the Research Associations.

A qualitative review of UK research spending changes by 20, predominantly larger, companies within the FDF membership, showed R&D to have increased in real terms over the five-year period 1987 to 1991, particularly in the area of food safety. Moreover, 90 per cent of companies reported funding some research in universities and institutes. Notably, 70 per cent of the sample reported taking part in Link projects and 25 per cent in European Community funded projects.

UK Public Sector Research

Whilst in comparative cost terms, the amount of food-related research in the public sector is small, it is critically important in providing the basic knowledge to underpin the industry's own programmes, and in providing trained people and expertise on which both the public and private sector can draw. FDF has therefore been concerned that the reduction and restructuring of the science base relative to the industry, which occured in the 1980s, should not weaken that base and disadvantage the UK food and drink industry and consumers.

We believe that it is critically important that the Science budget allocation to strategic research is augmented to sustain and extend the knowledge and science base which underpins the development of the food chain and ultimately its economic viability.

Equally, it is important that the strategic research programmes, and their underpinning science, support the *whole* food chain including the consumer. FDF has repeatedly stressed the importance of produce quality and market need in guiding agricultural research, and the need to achieve a more reasonable balance between agronomic and food related objectives. Further progress needs to be made to focus more of the AFRC and MAFF research effort on food rather than on agriculture, in line with the recommendations in the latest (July 1992) report of the Priorities Board for Research and Development in Agriculture and Food. At present 85 per cent of public sector research expenditure related to the food chain is on agriculture despite the fact that the added value generated by the food and drink manufacturing industry greatly exceeds that of agriculture.

These are issues which FDF believes must be seriously considered in developing the policy of the Office of Science and Technology.

RESPONSES TO SPECIFIC QUESTIONS

How can the process of turning research results into wealth creating technologies be improved? What might be the respective roles of OST and DTI in this?

The critical issues from the perspective of customers for the output of the public sector research system are:

(i) The initial decisions on research priorities.

(ii) The effectiveness of the mechanisms for transferring the research output to technical use.
(iii) The development of the human resource.

Technology transfer should be the responsibility of all elements in the research an development chain. FDF does not see a need for any new institution in the food sector to effect or assist this process. Government initiatives would, however, be valuable. Government departments should not be afraid to support competitive technological innovation. Since scientific knowledge diffuses quickly, measures should be taken to help UK science benefit the UK economy first. MAFF, in particular, appears ambivalent about its support of the competitiveness of the UK food and drink industry and should clarify its role.

The OST must be a body independent of the research community itself, which assesses the social and economic value of options for national research objectives and, presumably, implements agreed decisions. It must also have the responsibility for the appropriateness and effectiveness of the human resource which is critical to both scientific knowledge generation and technology transfer.

Other government departments have a clear role with respect to the public interest in the output for which the OST is responsible: DTI for technology transfer in general to improve competitiveness of industrial operations; MAFF particularly for food and agriculture; DoE and DoH in their respective areas of interest. The responsibilities of each of these departments both to promote their needs to the OST and to encourage technology transfer should, however, be made clear. It would be inappropriate for the OST to assume prime or sole responsibility for technology transfer which would duplicate existing industrial linkage mechanisms.

The legislative framework is a key influence on innovation in the food sector. The Government can, through its negotiations in Brussels and through the precedents it sets nationally, influence that framework on a European and international scale. Whilst consumer protection must be paramount in food legislation, some recent developments, such as the proposals for implementation of the Biotechnology Directives and the Food Advisory Committee's proposal on labelling of foods produced using genetic modification, go beyond the needs of consumer protection. Such approaches will reduce the UK's competitiveness by impeding innovation in this country.

Innovation can be seriously impeded by unneccessary bureacracy, procrastination or indecision on the part of regulatory bodies, and unjustified demands for information on the part of expert advisory bodies. It is not unusual for product innovations to be delayed for many years and investments to be held unproductive, thus losing their competitive lead. This situation has been aggravated by the delays in establishing the legislation and the mechanisms for its implementation at the European level.

The OST could have a key role in tackling these problems. Government departments, in reviewing petitions, should work to short time targets. Expert advisory committees should give reasoned justification of requests for additional information (which may take years to generate). Patent life extension should be considered for cases of prolonged regulatory review delays. A culture of collaboration to facilitate safe innovation needs to be adopted by Government and its advisers.

What structure does the Government need to advise it on Science Policy? Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate?

The structure which advises the Government on Science Policy must allow for input from both top level scientists and industrialists and be supported by an independent source of information and analysis.

Due to the diverse nature of the food and drink industry, it has interests within the areas covered by all of the Research Councils. FDF values the centres of excellence provided by the Research Institutes but recognises that their operation under different research councils can jeopardise and inhibit interactions. It is important, therefore, that collaborative mechanisms be established, both to ensure that there is adequate coverage of key industry interests and to facilitate effective focussing on overall priority areas.

Is it appropriate for the effective Chairman of ACOST to continue to be a businessman with a technological background, or should the Minister take the lead?

It seems wholly appropriate that the Chairman of ACOST should be a businessman with a strong technological background. ACOST will presumably become the external board of advisers to the Minister and the OST?

What should be the role of the Chief Scientific Adviser

The Chief Scientific Adviser's role should be that of:

(i) Assembling and assessing the options for priorities and organisation of public science and technology development, and advising the Minister accordingly.
(ii) Providing advice on science and technology implications to other departments.
(iii) Implementing and co-ordinating policy through the funding councils.

Are there any areas which experience particular problems such as, for example, UK participation in international collaborative programmes?

The UK Link schemes have been adopted widely by the larger food companies. In general, they are well thought of by the participants except for the bureaucracy in the establishment of these necessarily "precompetitive" projects. In particular, whilst there must be some planning for success, the intellectual property rights agreements between the partners, which are insisted upon by MAFF/DTI, are often regarded as wasting management time for no benefit to the project or its participants. Nonetheless, the scheme appears to be effective in bringing awareness of the applicability of scientific developments to participants, although it is too early to quantify the economic benefits.

Whilst there are examples of successful UK industry participation in European collaborative research projects, the level of such participation in general compares poorly with that in the Link schemes. There are several areas in which other European countries have advanced skills from which the UK might benefit including, for example, process equipment and packaging technology. More effective UK use of Community funds might be made if promotional and managerial effort similar to that supporting Link schemes was made for the European programmes. FDF believes that the responsible Government department should consider ways of generating more UK company participation in Community programmes.

Except for some technology development companies, there is little participation of small or medium companies in Link or European projects. Whilst progress in smaller companies may often be made by picking up technology elsewhere, it is likely that smaller companies would find the costs of taking part in projects beyond their means, except as a minor partner. Merchanisms for supporting smaller projects for smaller companies, which have commensurately less bureaucracy, should be sought.

What should be the objectives of the Minister as a member of the Council of Science Ministers in Brussels?

An important objective of the Minister should be to ensure that UK companies, Research Institutes and Universities benefit by obtaining a stronger participation in relevant Community research programmes and by building bridges with other European organisations, particularly in areas of perceived UK weakness.

The Minister should also identify UK science strengths and complementary and competitive groups in Europe.

The Minister should seek removal of barriers to innovation, some of which have been identified in the foregoing comments (page 3, second and third paragraphs).

Memorandum submitted by the Glaxo Group of Companies (23 October 1992)

1. Introduction

1.1 Glaxo is an integrated research-based group of companies whose corporate purpose is the discovery, development, manufacture and marketing of safe, effective medicines of the highest quality.

1.2 UK-owned, Glaxo is one of the world's largest and fastest-growing pharmaceutical companies, with a turnover of £4 billion in the financial year to 30 June 1992. Over 37,000 people are employed by Glaxo world-wide, about 11,000 in the UK. Glaxo medicines are sold throughout the world.

1.3 Ethical pharmaceuticals are the products of an innovative, science-based industry. The industry's success depends on research and development which is very expensive. Glaxo's current expenditure on R&D in 1991-92 was £494 million, around 14 per cent of turnover. In addition, a further £237 million of capital investment was devoted to R&D facilities.

1.4 The pharmaceutical industry in the UK makes a significant contribution to the economy and is a major export earner, ranking third after the power-generating machinery and petroleum industries. It has produced a balance of trade surplus for the last 40 years which in 1991 amounted to £1.2 billion.

1.5 The industry has been outstandingly successful in both innovation and exploitation and is critically reliant on scientific research for the discovery and development of new medicines. Most companies have developed their own in-house R&D facilities which, in the larger companies, are extensive. In 1990 the industry as a whole spent over £1 billion, or 16 per cent of gross output, on R&D. This compares with the 2 per cent of gross output spent by the rest of manufacturing industry on support for R&D.

1.6 The industry is a major employer in the UK and out of a total workforce of 87,000 its R&D activities now employ over 18,000 people drawn from many disciplines, with a high proportion of scientists and technologists. The range of expertise required for the process of medicine discovery and development is wide and includes most of the branches of the natural and physical sciences, biotechnology, chemical engineering, pharmacy, analytical technology, toxicology, computer science, statistics and medicine.

1.7 The industry operates in an international environment both in terms of the markets it serves and the scientific resources it draws on. It is critically dependent on a healthy public sector science base in those countries in which it carries out R&D, for a supply of well-trained, skilled and knowledgable personnel.

1.8 Companies such as Glaxo have a major interest in maintaining good science in the UK and in the influence the UK government can exert in promoting the development and maintenance of scientific research elsewhere, through international collaboration and co-ordination.

1.9 We welcome the appointment of a Minister of Cabinet rank in charge of Science. We will be making a full submission to the Office of Science and Technology as a contribution towards the publication of the White Paper planned for 1993. We welcome also this inquiry as a valuable contribution to the debate on this subject. This paper to the Committee addresses those issues which we will be covered in our submission on the White Paper.

1.10 As far as possible we have addressed our comments to the questions posed by the Committee's terms of reference. These appear in Section 2. As a private sector company involved in one aspect—albeit an important one—of Research and Development, we are not in a position to respond to all the questions posed. Those to which we have responded are in the order they appeared on the Committee's terms of reference. A summary of our responses is set out in Section 3.

2. Key questions

How can the process of turning research results into wealth-creating technologies be improved? What might be the respective roles of OST and DTI in this?

2.1 The UK has a strong tradition of scientific and technological achievement. In the past it has led the world in both innovation and development. In recent years our scientists have operated in an increasingly competitive and international environment and that initiative has been largely lost; in the case of micro-electronics, to Japan; in the base of biotechnology to the USA, for example. Yet even in these areas innovative British science was often the starting point.

2.2 It is not innovation that has been lacking. It has been the ability to exploit these innovations effectively. This has been left to others to achieve at the UK's expense.

2.3 The first need, therefore, is to encourage exploitation and support those who are prepared to take risks to do this. This applies not only to the individual scientist or technologist who discovers the technology but to industry itself which has failed to capitalise on UK discoveries. In the USA, by comparison, academics have been more prepared to establish their own companies to exploit their ideas and discoveries outside the protection of the college environment.

2.4 The second need is to encourage scientists and engineers to adapt to changing demands and take up new challenges, particularly in the industrial sector. Too many professional scientists become entrenched and within their own specialisation and are not prepared to move out. To a large extent the pattern of academic career progression and grant support encourages this approach. Industry, and particularly the pharmaceutical industry, needs well trained but also adaptable scientists and engineers.

2.5 A third need is to ensure that there is an effective transfer of ideas from innovators to exploiters. In the pharmaceutical industry this is not usually a problem because most of the inventive and exploitative steps are taken within a company and there are organisational structures linking the one with the other. This may not be the case in other sectors, particularly those relying on academic research. However, various means are, or could be, available, for effecting early "technology transfer" to industry.

Research Councils

2.6 The Research Council could be more proactive in drawing industry's attention to advances funded by them, or made in their laboratories or units. The MRC has made some progress with the establishment of its industrial unit. Higher Educational Institutions (HEIs) could establish similar mechanisms and universities such as Strathclyde and Oxford have made serious efforts to do so. However it is important that these functions are managed by professionals with experience in the field, who can identify real opportunities and valuable inventions.

Research Collaborations

2.8 A major concern for the pharmaceutical industry is the growing trend of patenting products arising from biotechnology and then attempting to licence these entities, which are usually no more than research tools, for large and often unreasonable sums of money. This practice, and in particular the recent applications for patents for DNA sequences from the human genome with no known function, will cause considerable intellectual property problems for companies and could result in these products not being exploitable. Control of these practices, or a reasonable approach to them, is now becoming urgent.

The Faraday Centres

2.9 More promising, particularly for smaller firms, is the Faraday Centre concept and the pilot scheme introduced by the DTI. The concept is intended as a means of providing an interface between originators of new science and technology (the HEIs and Research Institutes) and companies which could exploit them. Such centres will require a reasonable and long term government investment.

2.10 Glaxo Group Research has recently established and fully funds an "Institute of Applied Pharmacology" within the University of Cambridge with similar features. The initiative aims to encourage close interaction between academia and industrial scientists allowing early exploration of technology and its exploitation.

Strategic Alliances

2.11 A further means of ensuring technology transfer and exploitation is by the formation of alliances between generators of potentially valuable enabling technology and those companies capable of exploiting it. Small companies which discover new technologies can be assisted to develop them as tools, or products, with the support of the complementary interests and skills of the larger exploiting company.

2.12 Glaxo has developed several such strategic alliances to exploit novel concepts in the discovery of new medicines. However, all are outside the UK because other countries seem far more prepared to encourage the entrepreneurial talents of academics. In the UK the economic and employment climate discourages risk-taking. Financial backing is not readily available and many British academics have actually set up companies in countries such as the USA, where venture capital seems easier to acquire.

The role of government departments

2.13 If some, or any, of these initiatives are to succeed it is important that a new structure for the support of science and technology is established and given the power to determine policy together with the necessary financial resources.

2.14 The appointment of a Minister of Cabinet rank with special responsibility for science and the development of the Office for Science and Technology within the Cabinet Office are encouraging recent developments which suggest that the state of UK science is beginning to be taken seriously. It is the OST rather than diverse individual departments that must now become the prime, if not sole, focus for science policy.

2.15 The Government already intervenes heavily in the pharmaceutical industry. The Department of Health controls the profits and prices of ethical (i.e., prescription-only) medicines, whilst the Medicines Control Agency (now an Executive Agency) issues licences without which medicines may not be sold. Whilst the Department of Health clearly has short-term interest in securing the lowest prices for the medicines it uses, it is important that it should continue to recognise the need for the industry to fund research in the long term and its contribution to the science base and the wider economy. The OST could help here by acting as the lead in a cross-departmental policy group, ensuring that other departments such as DoH address the needs of science in their individual policies. This would mirror the work of for example the Departments of Health and of the Environment in ensuring consistency across government with the strategies to improve health and environmental protection, respectively.

What structure does the government need to advise it on science policy? Are the existing bodies (such as ACOST, ABRC and the funding councils) appropriate? Can any problems which arose from the previous ways in which science policy was co-ordinated be identified?

2.16 Under the previous system responsibility for, and financial control of, science was spread too widely amongst the government departments and so lacked the degree of focus needed to ensure optimum value from the UK's investment in science.

2.17 The advisory bodies such as ACOST, ABRC and others seemed unco-ordinated so there was always the possibility of conflicting signals reaching government.

2.18 An important role for the new Office of Science and Technology should therefore be to remedy this situation by providing an effective co-ordinating function. It should consult widely on science matters and ensure that the voices of both public and private sector science and technology are heard.

2.19 Finally it should encourage and engender a cohesive, focussed and effective science policy. This must embrace education, training, research and exploitation and be capable of being put into effect by government departments, the Research Councils, Higher Education Institutes and science-based industry.

Are there any areas which experience particular problems such as, for example, UK participation in international collaborative programmes?

2.20 The UK now faces serious international competition not just for ideas and innovations but also for scientifically educated people. The UK's **Science Base** has been allowed to decline. Remedial action is now urgently needed. We welcome the opportunity that the present examination of the UK's scientific and technological resources provides to bring about the required changes.

2.21 The Science Base embraces science and technology not only in the public sector (HEIs and RIs), but also industry. It is a valuable national resource and requires effort on the part of academia, government and industry to ensure its health, vitality and utility. The pharmaceutical industry depends upon the science base for the provision of scientifically and technologically skilled people, not only to provide staff for their own R&D facilities, but also to ensure the growth of new knowledge in academia on which innovative medicines research depends.

2.22 Large companies with significant R&D facilities require trained scientists and technologists who are capable of working in teams. The present system of graduate, and particularly post-graduate, training does not develop this ability. The trend in HEI courses is now away from training students in the practical skills of their subject which is detrimental from the industrial point of view. There is no shortage of well qualified people available to the larger companies but this is due mainly to the levels of salary that are now being offered. This however has a detrimental effect upon the numbers and quality of scientifically qualified personnel available for recruitment by the smaller companies, HEIs and RIs. Overall, the number of scientific and technical candidates available for employment is declining and companies are having to work harder in the recruitment process.

2.23 The decline in numbers must be reversed and this can only be achieved by encouraging school children to become interested in science from an early age and to see science and technology as a career. Positive effort is required to overcome the apathy which many display towards science and to build up a better image of the scientist and engineer in the community.

2.24 There is a need to correct the deficit in training in practical skills in science and technology students, so that industry receives well trained individuals and does not have do to the HEI's job for it.

2.25 Many industries rely upon the external science base for the creativeness and innovation which they can then exploit. Other companies, such as Glaxo, rely on their own scientific staff to provide a large measure of this creative activity but do need to develop interaction with academic groups to carry out some of the more fundamental inquiry research. It is this research that often points towards new target mechanisms for therapeutic intervention, so leading on to drug discovery. Thus well equipped, knowledgeable and skilled academic groups are important for the health of UK industry in providing the powerhouse for innovation.

2.26 If public sector science is to survive and develop there needs to be a commitment to reversing the present low morale amongst academic scientists, by offering reasonable financial rewards, providing a good infrastructure for the HEIs and RIs, and actively encouraging collaboration with industry. There must be a good interaction between public and private science sectors with the development of partnerships in which each has a defined role to play. In the case of the pharmaceutical industry it is the role of the academic to carry out the research necessary to understand complex processes underlying normal and diseased tissue function. It is the role of the company to use the results of this research, collaborate in future research and develop the new concepts to provide new medicines.

Science Education

2.27 Radical changes are needed to science education at every level from schools up to research departments. Children should be exposed to science at an early age and their interest maintained throughout their school careers. This means that primary teachers will need an understanding of the sciences and good facilities.

2.28 In the secondary schools the learning of the separate sciences should be encouraged. There is a danger that the recent introduction of combined sciences at GCSE level could detract from this by offering an easy option which could result in students going forward to "A" level studies in individual sciences without the essential foundations. This will lead inevitably to declining standards at this level which in turn will have consequences for university teaching. Whilst it must be right to encourage more pupils to gain some knowledge of science this should not be done at the expense of those who will be the career scientists of the future.

2.29 The traditional pattern of science education at degree level also needs serious modification. The present system no longer effectively meets the needs of science-based industry. New graduates generally have a good theoretical knowledge of their subject but are often poorly equipped to apply it in the laboratory because they lack practical training. A significant number of science graduates will seek careers in non-science based areas, yet they will have followed the same training programmes as the intending career scientist.

2.30 Degree courses should be restructured to meet the different needs of these two categories of student. One alternative might be to offer a basic degree or diploma course providing essential grounding in the principles of particular sciences, scientific method and analysis. Following this first qualification the student intending to develop his scientific understanding would proceed to advanced studies of his subject with an emphasis on laboratory experience, project work and problem-solving as a foundation for a career in science. Those not intending to pursue such a career could pursue courses in other academic disciplines or enter vocational training. In such a way scarce practical teaching resources and facilities could be concentrated on those students more likely to benefit from them.

2.31 There is a scope for academic/industry partnership in the provision of scientific education. HEIs should consult with industry in the design of syllabuses to ensure relevance of training. HEIs should also recognise the opportunities that exist for involving industrial scientists and technologists in their teaching programmes. Such involvement could be effective in conveying to the student the immediacy and excitement of science in industry. The "sandwich course" principle could be extended amongst all HEIs to allow selected advanced course students to gain experience in industrial laboratories. Companies could also provide practical training on advanced equipment.

2.32 It is inevitable that the current first degree courses will need to extend over four years even if there is no restructuring. The scheme suggested above could be accommodated in this timeframe and would produce good quality scientists and scientifically aware personnel for other occupations.

2.33 The PhD is seen as an essential part of the training of many professional scientists and technologists, yet under the present system there is much that is often left to chance. The nature and purpose of the PhD course should be reconsidered. The inclusion of a formal taught advanced course in the particular area of science, or peripheral areas, would be advantageous to the student. Research projects should be planned to give the student a broad appreciation of the scientific method and develop his scientific and technical skills and an ability for team work. There is evidence that the quality of supervision provided for the student in some centres is declining and this must be remedied. Particular attention needs to be given to the supervisory load placed on some senior academics. It is also important that PhD students are placed in departments that are well equipped, with facilities for high standard research. The view that the best research comes out of "string and sealing wax" laboratories is outmoded.

2.34 Funding for PhD students is unrealistic and many students have great difficulty living on the low stipend provided by most grants. It is not surprising therefore that PhD candidates increasingly take up research assistant posts rather than accept training studentships. From the point of view of their training this is not satisfactory and steps should be taken to provide realistic grants.

2.35 We support the co-operative award schemes such as the SERC's CASE awards, which allow academia and industry to be jointly involved in the training of PhD students. Such schemes not only allow the student to gain experience of research in the industrial environment, they also bring the academic and industrial supervisors together and foster mutual understanding. Such schemes should be encouraged and made attractive to smaller and medium size companies as well as larger firms.

2.36 With the change in status of the old Polytechnics, the restructuring of the funding Council for the HEIs and changes in the "dual support" system, the time is ripe for a critical re-examination of the structure of higher education in the UK. If these changes are not to be accompanied by a significant increase in funding for the HEIs and RIs then it is important that the funds that are available are used in the most effective way. This will involve challenging entrenched attitudes and views.

2.37 It is important that the valuable function that the "new wave" universities have performed in the past, in training relatively large number of students to a high standard, are not lost in a rush to become traditional style universities. The dogma that a research environment is essential for the effective teaching of undergraduates must be challenged. The development of "teaching HEIs" (which would undertake post-"A" level teaching) and "research HEIs" (which could undertake the higher level teaching) is desirable and probably inevitable if financial resources are to be most effectively deployed to support both teaching and research. The alternative, in which every HEI is entitled to conduct both teaching and research, will result in the limited funding being spread too thinly and both activities compromised.

2.38 The status of academic staff, whether teachers or researchers, must be improved as an important part of improving the image of science in the community and to encourage well qualified young scientists to look to HEIs for their carers. Career development from post-PhD onwards is urgently needed.

2.39 It is essential that the funding of research in the HEI sector is soundly based to ensure the strength of basic, or inquiry, research. This requires the provision of a secure infrastructure with state-of-the-art facilities, adequate provision of support staff and funding for running costs of research projects. Central funding should be available for the first two items. Support for specific projects could then be provided by research councils, government departments and industry.

2.40 The structure and functions of the Research Councils should also be given careful consideration. The present structure has disadvantages for medically related biology and chemistry, for example. Applications for support for projects in these areas can fall between the MRC and the SERC and so not obtain finance. The funds available to SERC must cover a very broad area of science which includes the so-called "big science" which is extremely costly, and also international projects. There is a case for completely restructuring the Research Councils to better fit the needs of scientific and medical research and allow more coherent national research strategies.

2.41 As far as the pharmaceutical industry is concerned there is now a need for more focussed and long term investment in research into the mechanisms underlying important and common diseases such as the senile dementias and rheumatoid arthritis. The solution to such problems will not come from projects supported by short-term three year grants which are now almost the rule. We would urge more long-term support for directed projects in a number of fields which could be identified as priority areas. An example fo such an approach is the one adopted by the Biotechnology Directorate for SERC for their biotransformation projects. Partnerships between the Research Council and appropriate companies could be developed on this basis.

2.42 We support the development of the LINK programme concept but on a basis that encourages closer collaboration between the industrial and academic partners. However these schemes need to be less bureaucratic than at present. The development of Interdisciplinary Research Centres also provides a means of optimising the use of costly resources and can bring about by academic groups across a number of scientific disciplines. These could also provide opportunities for collaboration with industry and technology transfer.

Training in science and technology

2.43 Industry needs individuals who have an awareness of mainstream sciences as an adjunct to their main activities. The basic level qualification would be appropriate for such people who could then go on to receive training in their chosen profession or vocation. Such "parascientific" personnel with the ability to put scientific issues in perspective and see possiblities for innovation or exploitation, would be invaluable.

2.44 Over the last two decades there has been a decline in the availability of trained technicians. Their place has been taken by graduate scientists, often holding lower grade degrees. Those who would have taken up careers, and been trained, as laboratory technicians have chosen instead to take a degree course, often in polytechnics. The result has been the loss of valuable technical expertise. Technical careers must be encouraged, the opportunity given for training, both in service and in the HEIs, and the status of the qualified technician improved.

3. SUMMARY OF RECOMMENDATIONS

3.1 The UK has lost its lead in exploiting innovative developments in recent years (paragraph 2.1).

3.2 Exploitation of new discoveries by those individuals and industry prepared to take risks, should be encouraged (2.3).

3.3 Scientists and engineers need to be more adaptable to change. The present pattern of academic career progression and grant support does not encourage this (2.4).

3.4 New iniatives are required to ensure effective transfer of ideas from innovators to exploiters (2.5).

3.5 Research Councils, Research Collaborations, Faraday Centres and Strategic Alliances all have a role to play in this (2.6-2.12).

3.6 The appointment of a Minister with Cabinet rank with special responsibility for science and the development of the OST suggest that the state of UK science is beginning to be taken seriously (2.14).

3.7 The OST must now become the prime focus for co-ordinating science policy and should ensure that specific policies of other individual departments are consistent with it. (2.14, 2.15, 2.18, 2.19).

3.8 The UK's science base has been allowed to decline. Remedial action is urgently needed (2.20).

3.9 Radical changes are needed to science education at every level from schools to research departments (2.27-2.42).

3.10 The decline in availability of trained technicians should be reversed (2.44).

Letter to the Clerk of the Committee from Professor John Andrew, Chief Executive of the Welsh Funding Councils (22 October 1992)

I wrote to you on 8 September regarding the evidence sought by the Select Committee on Science and Technology in regard to the establishment of the Office of Science and Technology. I had hoped that following the meeting of the Council on 1 October I would be able to forward to you a copy of the submission to be made to the Office of Science and Technology regarding the forthcoming White Paper. However it is now expected that further discussions will take place in the preparation of that submission. Accordingly I thought that it might be helpful, given your tight timetable, if I were to offer some preliminary observations. These are presented below, together with a brief description of the Council.

The Higher Education Funding Council for Wales

The Council came into being on 6 May 1992. It is a body corporate, established by virtue of the Further and Higher Education Act 1992, which set up separate higher education funding councils in England, Scotland and in Wales. It is responsible for administering funds made available to it by the Secretary of State for Wales and others for the provision of education and the undertaking of research by higher education institutions (HEI) in Wales and the provision of facilities and the carrying out of other activities by these institutions which are considered desirable in connection with education and research. It may also fund the provision of higher education courses at further education colleges in Wales. The Chairman of the Council is Sir Idris Pearce and there are 10 other members each appointed by the Secretary of State.

The Further and Higher Education Act 1992 also established separate further education funding councils in England and in Wales. In Wales both the Higher Education Funding Council and the Further Education Funding Council are served by a single administration of which I am Chief Executive. As such I am a member of both Councils. Staffing for the administration is currently being built up. It is expected that when at full strength there will be approximately 45 members of staff.

Questions posed by the Select Committee

The Committee has posed a number of questions that might be addressed. Given that the Council has only recently come into being it is best at this stage to confine observations to those questions directly relating to its responsibilities. These concern the appropriateness of existing bodies and of the need for better co-ordination between the research councils and the funding councils.

Whilst the Council has already established working relationships with the other higher education funding councils it has only begun the task of developing links with the other bodies mentioned. In general it is therefore rather early for Council to take a view on the appropriateness of other bodies. It is clear however that it has a crucial role to play in regard to the research contributions of higher education institutions in Wales. This is encapsulated in the dual support system whereby a funding council supports the basic research undertaken by academic staff which is essential if knowledge and speculative ideas are to be generated and taken to the stage where they are focused enough to attract support from external sponsors, and provides for a research infrastructure which helps to support research the bulk of whose costs are provided by research councils. This underpinning role is crucial to the well-being of the research efforts of HEIs and was endorsed in the White Paper "Higher Education: A New Framework" (Cmnd 1541) published in May 1991. The Council will work closely with the other funding councils in maximising the use made of research funds, through the pursuit of a policy of selective distribution and by seeking ways of ensuring greater accountability for these funds. It will also wish to stimulate innovation and ensure that institutions' research programmes do not stagnate. In these activities the Council is particularly well placed, given its overall responsibility for the funding of the institutions concerned and the overview that this provides.

On the basis of the above observations it can be seen that collaboration between the Council and the research councils is based on the complimentarity of the roles each body has to play within the dual support system. At this stage the Council is unable to comment on the efficacy of relations between funding councils and research councils since it has only begun to establish these relationships (it has already agreed that Sir David Phillips be invited to attend meetings as an observer). Given its overarching role in regard to HEIs in Wales it is determined to ensure that the partnership between institutions, the Council and the research councils works to maximum effect. One of the first acts of the Council has been to establish a Research Group under the chairmanship of Sir John Cadogan, and I know that the Group, as part of its deliberations, will wish to tackle this issue.

The Council also sees itself as having an important role in maximising the use made of public funding of research in Wales and of furthering links between HEI's on the one hand and public bodies and industry in the Principality on the other. The Secretary of State for Wales has already identified this important role in his letter of guidance to the Council. Both through its Research Group, and by other means the Council will wish to work with the Welsh Office and other agencies in furthering this aim.

I trust that these observations are of assistance. I will send you a copy of the fuller submission which we hope to make to the Office of Science and Technology when that is ready.

Memorandum submitted by AEA Technology (28 October 1992)

VIEWS OF AEA TECHNOLOGY ON THE QUESTIONS TO BE ADDRESSED IN THE WHITE PAPER ON SCIENCE AND TECHNOLOGY

1. Introduction

We welcome the opportunity to respond to the questions posed by William Waldegrave.[1]

The AEA's views on technology policy reflect our experience of changing from a role dominated by a Government-funded mission to a role in which we must provide technological services on a fully commercial basis. AEA Technology now has over 5,000 customers and is a major interface for technology transfer to UK industry. We therefore fall into the category of an IRTO (Independent Research and Technology Organisation) moving towards privatisation. Our experience has shown that technology transfer is best achieved within a commercial environment where survival depends upon a clear recognition of market needs and opportunities.

The next section provides an overview of our suggestions on a policy to enhance technology transfer; this is followed by our answers to the specific questions posed by William Waldegrave.

2. Policy to enhance technology transfer

2.1 *The Role of Government*

In our view, technology transfer is most effective where it is motivated by business objectives. Its successful implementation requires the discipline of commercial targets for market share and return on investment, and a corresponding organisational system and culture.

Technology transfer is also essential in reinforcing UK industrial competitiveness, in both the manufacturing and service sectors of the economy. However, innovation is an area where market forces are imperfect. Therefore, Government should provide a policy framework which facilitates efficient technology transfer. In particular, we suggest the OST and DTI have a key role to play in:

- Identifying areas which have a strategic importance to UK industrial performance as a whole.
- Facilitating the effective interface between technology suppliers and industry in these areas, e.g., by funding information flows and technology demonstrations.
- Ensuring that graduate and post-graduate training meets industrial needs, with respect to quantity, quality and relevance.
- Focusing Government investment in applied science and technology into organisations which combine market awareness, technical expertise and experience of technology transfer.
- Supervising the public funding of fundamental technological research in academic institutions.
- Identifying and removing any regulatory or market barriers to technology transfer, e.g., affecting eligibility for Government grants, access to long-term funding, and competition for human talent.

The problems of technology transfer have their foundation in a failure to match technical opportunities with market requirements at all stages of the innovation process. Industry in particular has generally not been able to recruit its fair share of the *best* science and engineering graduates, able to interpret state-of-the-art scientific knowledge in a market context. Industry's technical graduates have therefore not risen in sufficient numbers to senior positions to influence investment decisions and the ability of industry to recognise useful innovative science has perhaps been impaired (e.g., the early rejection of ion implantation and slow uptake of fibre optics).

The supply of well-trained graduates for industry could be improved in the long-term by the successful development of Faraday Centres. In the short and long-term we believe that Government would secure more effective returns on its national investment in technological development by contracting IRTOs as its agents for technology transfer. IRTOs are also particularly good environments for Faraday Centres for the reasons given in the next section. Two partnerships have important contributions to make: the partnerships between HEIs and IRTOs (through Faraday Centres for example) and that between IRTOs and industry for technology transfer.

2.2 *Graduate and Post-Graduate Training*

Higher Educational Institutions (HEIs), particularly universities, are being asked to perform too many conflicting roles. They are currently trying to provide teaching at graduate and post-graduate levels, to do fundamental research, applied research, contract research (often confidential) and to promote technology transfer, etc. They need clearer guidance on how to focus their activity. Teaching should be one of their two primary roles and it is one that is being increasingly starved of attention. The other primary role should be fundamental research, complemented by a close interaction with industry to facilitate technology transfer (e.g., Technology Shops).

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[1] See evidence p. 156.

Proportionately fewer post-graduates are able to make a career in universities than in the past and therefore fewer should be trained in a purely academic environment, a training generally lacking exposure to the problems of technology transfer and industrial exploitation of research. More post-graduates should be trained outside universities for careers in industry. We therefore fully support the Government initiative to establish "Farady Centres".

The training in Faraday Centres should include business skills such as marketing, investment analysis, IPR and project management, etc. The Independent Research and Technology Organisations (IRTOs) such as Industrial Research Associations and the laboratories of Trading Fund organisations like AEA Technology, are particularly good environments for such training since they operate at the interface between academia and industry, with windows onto both the frontiers of science and industrial exploitation. In partnership between universities and IRTOs, students can be guided with dual supervision in applied research projects in an atmosphere that combines high scientific and technical quality with a continual regard to the exploitation and communication of research. More than 2,000 graduates who have gained experience with the AEA in the last 20 years are now in industry and commerce. However, the UK would certainly benefit if more students had similar training. Some Faraday Centres which focus on a particular industrial sector could be expected to become centres of excellence in propagating "carrier technologies". Post-graduate training in institutes dedicated to technology transfer is much more likely to produce post-docs of more immediate value to industry than if the training is undertaken in HEIs. However, it is important that academic standards set by HEIs are maintained.

Laboratories in other European countries such as Fraunhofer Institutes and French National Laboratories (Saclay, LETI, etc.) have a substantial educational role, alongside the University sector. In a similar vein, the Belgians regard their involvement in CEC-funded research programmes at IMEC, their premier research institute, as a route to improving the quality of its workforce and the technical level of related industries.

3. Response to questions to be addressed in the Government White Paper

This response to the questions posed by William Waldegrave is a collation of views of senior managers in AEA Technology. The order of the responses is the same as the order of Mr Waldegrave's questions.

3.1 (a) *Poor exploitation of inventions by UK*

The cultural climate in the UK is not as pro-science and technology as in other successful innovative countries—many of the best people either do not enter or continue with science studies. For example, in 1991 23 per cent of the first degree, scientific, engineering and medical graduate output from Imperial College went into banking, insurance and accountancy. The self regulated professional bodies (e.g., for doctors, lawyers and accountants) achieve high salaries and status with which science and technology posts in industry cannot compete. The development of similar bodies to promote and assure standards in technical specialties, currently being pursued by UK scientific and engineering institutions, should receive Government attention and support.

Degree courses where a science subject is combined with marketing or business studies should be encouraged. A purely scientific training can lead to a technology-push rather than a market-pull ethos, and needs to be balanced with an appreciation of commercial issues.

Public funding of the innovation process should be limited to the development of targeted core technologies and should be freed from its present linear pattern of sequential funding for separate research, development and exploitation stages. Preliminary development and exploitation considerations should be funded at the research stage (see Section 3.2(d)). Although Government's R&D decisions may be correct they are often too slowly implemented, which is damaging. Management of some programmes should be devolved to external agencies with clear budgets, timescales and targets. Innovation is a race against competitors.

Consideration should be given to providing tax incentives for R&D to encourage companies to break-out from the constraints of an investment analysis weighted against long-term research; such constraints are a common reaction to the present economic environment in the UK. Consideration should also be given to establishing a National Research Bank to provide funds for R&D at internationally competitive rates, and the accounting standards in relation to R&D spend by a company should be rigorously enforced. The DTI's R&D league table should be continued.

In order to minimise the costs of innovation a company may need assistance from an organisation able to provide practical help by arranging for trials, demonstrations, prototypes or samples using in-house facilities at reasonable prices either on an individual basis or in collaboration with other companies through a club arrangement. IRTOs have traditionally worked in this way and AEA Technology is a prime example.

3.1 (b) *Why are some industries more successful than others (in translating inventions to market place)?*

Some industries, for example pharmaceuticals, are more successful than others because the relationship between R&D, innovation and commercial success is obvious and continual innovation is necessary to survive. In the UK, the Department of Health has appreciated the need for investment and has accepted a purchase price for drugs that allows continuing, adequate investment. In addition, protection of intellectual property rights has proved effective in the pharmaceutical area, which increases company confidence by lowering the risks of long-term investment.

For other industries success is possible without significant technical innovation; in such cases, a low-investment strategy may be encouraged by uncertainty and the cyclic record of the UK economy.

ICI has been successful for many decades. The steady income from its relatively stable bulk chemical sales (sulphuric acid, fertilisers, plastics, fibres, etc.), which require relatively little innovation, has been used to fund innovation in other areas. Its broad base of R&D and technology can also support innovation in many different product areas. A failure of one innovation does not jeopardise the organisation as it would a small company with only a few products and few financial reserves. Overall, ICI's managers over the years have been able to maintain a culture and organisational style conducive to innovation and retain the confidence of its investors. Of course, an organisation can become too big, such that its internal bureaucracy slows down its more dynamic parts. This is presumably the reason for the current move to divide ICI into two companies.

Innovation is also spurred by competitors, provided the competition is not overwhelming by virtue of low labour costs, etc., and by the realisation that a competitive advantage can be achieved.

Small companies in highly specialised sectors are generally considered to provide an environment more conducive to radical innovation than large ones. However, the exploitation effort is usually relatively small scale, ideas often stem from developments and funding elsewhere such as in universities and development usually involves a key individual with the knowledge of the technology. Thus, the company has not had to fund the initial investment and may well have to be taken over by a large company in order to exploit the innovation effectively.

Thus, in general terms, success in innovation can be associated with:

- Company size—a large organisation combines in-house the breadth of technical awareness/expertise and market knowledge needed to realise new opportunities, together with the financial strength to develop them and accommodate the risk of failure, but may stifle radical innovation.
- Confidence in the regulatory framework for protection of intellectual property rights.
- The competitive environment—where innovation is the main arena for competition in the industry, and market conditions and economic environment encourage long-term investment.
- The resource base—where the industry needs an adequate supply of expertise and technical capabilities (e.g., influenced by the Government's education and technology policies).

3.2 (a) *Agreed measure of innovative capacity*

None exists and it would be unrealistic to attempt to define a single measure. (It would be as dangerous to use as IQ as a single measure of a person's value to a company). Patents and licences granted to manufacturers are important components of a measure of past innovative capacity. The capacity also depends on the existence of a market that wants innovation. There is no point in innovating if no customer need (expressed or latent) exists.

3.2 (b) *Are our companies innovating better or worse than in the past?*

Doubtful if we really know but we do know what kind of training would probably help. (See Section 2.2).

3.2 (c) *Do technology-based innovative companies survive longer (than non-innovative technology-based companies)?*

Yes generally, other important factors (such as size) being equal, but excessive innovation could lead to financial collapse (e.g., Rolls Royce and the RB211 engine). However, it would be presumptive to identify innovation as the primary *reason* for good performance; survival is a multi-factored business issue, and innovation is just one common attribute of companies that prove successful. Moreover, we note that technology-push style of innovation is oftern inadequate; effective innovation requires a close coupling to market needs and excellent capabilities in developing the exploitation route.

3.2 (d) *What is lack of innovation due to?*

It is due to a failure to couple technical knowledge/expertise/opportunities with market needs/opportunities and then undertake an integrated research, development and exploitation plan while maintaining technical and market inputs. The correct coupling is often more important than the brilliant execution of separate components. Points made under Section 3.1(a) are also relevant here. UK companies do not appear to get the most from technology imports (owing to the Not Invented Here syndrome).

Successful examples of innovation arising from bought-in technology should be publicised. For example, safety technology in the nuclear industry has been successfully transferred to the oil industry. Another example, in relation to introducing best-practice into industry, is the Energy Technology Support Unit (ETSU) within AEA Technology. ETSU is considered by the International Energy Agency, the National

Audit Office and the CEC (DG17) to have been an excellent and cost effective organisation in securing energy efficiency improvements in industry. These results have been achieved by targeted marketing to explain to companies at length how they can improve their energy efficiency, citing the results of demonstration projects that ETSU has managed. This is an example of an organisation acting as a direct instrument of Government R&D policy. Units like ETSU within IRTOs should be established to promote the adoption of other new technologies by British industry, such as advanced methods for corrosion monitoring, plant life extension, modelling and assurance of structural integrity and plant reliability.

3.3 *Do we need more or less planning in Government?*

Less planning but better, within a Science Policy which embraces more coherent structures such as Faraday Centres for technology transfer, catalyses exploitation, and provides public funding to develop core technologies. Government should permit any organisation to compete for funding from any Government source, removing current obstacles. OST's co-ordination of Departments' programmes would disclose multiple funding of the same technological development.

In our view, Government policy should not focus so much on planning as on providing support and advice, and legislating to improve market efficiency, to stimulate market-led technology transfer.

3.4 *Do we get optimum benefit from our international collaborative programmes and do they complement our national programmes very well?*

Probably not optimum but the UK certainly gets a fair share in relation to our financial contributions.

On the whole they are probably reasonably complementary. Again the focus of CEC rules on the linear model of innovation is probably mistaken. Investment will probably be much more useful to all concerned if considerations of exploitation were properly coupled in the proposals—instead of being deliberately decoupled to avoid "near market" criticisms. CEC programmes do not seem to be well co-ordinated with British ones in the oil sector.

3.5 *Does the UK get best value from Government expenditure on science and technology?*

No. Although Government Department decisions may be correct they are often inplemented too slowly. There is also a lack of co-ordination between ministries which OST should try to correct. Ministries commission reports but often no action is taken. The reports' recommendations should be either accepted or rejected publically with the reason(s) for the rejection.

3.6 *Are Government's spending priorities right?*

No. The responsibilities of the various institutions and Government programmes involved in the UK's science and technology investment need to be revised and clearly defined. Government funding can then be focused, and performance measures set, to ensure that expenditure is well-managed and effective.

Funding criteria should be changed so that Faraday Centres and industrial laboratories can compete for Government financial support for research proposals on equal terms with the HEIs. The principal measure of performance should be the value of the product (be it a trained person or successful commercial innovation) to UK Ltd, in relation to the scale of investment.

OST is involved in identifying key technologies that benefit British industry. These technologies should be the focus for investment in industry, IRTOs and HEIs. The benefit to UK industry of the UK's expenditure with CERN and ILL (for example) and other large projects should be reviewed. Too much of UK's investment in basic science is locked into large inflexible programmes for many years ahead. However, there is a motivational element in the "Grand Challenge" type of research that the country needs to encourage young people to study science. The benefits to British industry of defence R&D should also be considered in the review and necessary changes made to improve the expenditure/benefit ratio.

3.7 *Does the Government have the right advisory structures?*

We believe an advisory body like ACOST should exist but should have a strong supporting technical secretariat to ensure that well-informed decisions are taken. We consider that its terms of reference should require it, as at present, to identify what is wrong with any aspects of science and technology. However, in addition it should be commissioned to recommend specific actions to remedy any perceived deficiences in the existing situation. Such recommendations should have "teeth" which probably means that the body must have an "action budget" to catalyse change. ACOST should also have individuals with a good knowledge of IRTOs and the CEC. IRTOs are hardly represented on any Government fora yet they are important agencies for science and technology transfer. Hitherto, a weakness of advice and advocacy on the science budget has been that it is isolated from the mainstream economic and industrial policy making. The Office of Science and Technology is in an influential position and can correct this weakness.

The advisory structures used in Germany, France and Japan should be considered in the White Paper and the reasons for using or not using similar structural elements should be stated.

3.8 *How to increase industrial R&D expenditure*

The points made in the final paragraph of Section 3.1(a) are relevant here. In addition, Government legislation and regulation, for example in relation to pollution control, can force companies to introduce new equipment and encourage an accompanying innovative step.

3.9 *Could the links between academia and industry be improved to encourage maximum exploitation of the science base?*

Most large technological organisations have good links with academia. Links are likely to be deficient with small and medium enterprises (SMEs); their solvency position is a deterrent to them being drawn into two to three year collaborative programmes involving Government, CEC or other funding organisations. The Technology Shops established by some HEIs can help and should be encouraged. Teaching Company Schemes operated by the SERC also seem to be effective. More of everything relevant is required.

3.10 *Is the UK working in areas of basic science which have less marketable derivatives than those on which our international competitors concentrate their efforts?*

Broadly, no, but we may be spending a higher percentage of the UK basic science funds on defence, high energy physics and astronomy.

3.11 *Is there scope for improved training in science and technology?*

Yes, by providing training for substantial numbers of post-graduate students in the UK's IRTOs (see Section 2.2, paragraph 3). All students would benefit from short courses on practical communication skills, and on business topics such as marketing, finance, economics, quality assurance and project management. This would create a market-pull rather than a technology-push ethos. All "A" Level students and undergraduates should be required to learn the importance of science and technology to the development of civilisation and growth in economic activity and living standards. There are some excellent texts (such as Bronowski's "The Ascent of Man").

3.12 *What steps do we need to take to improve the status of scientists and engineers?*

Higher status will result from clearer definition of responsibilities and professional requirements, demanding standards for registration and higher rewards, as well as a better public appreciation of the returns on technical investment. OST should have an advertising budget to get across the value of science and technology and should liaise with COPUS (Committee for the Public Understanding of Science) and the British Association for the Advancement of Science to raise public awareness. Government should review the activities of relevant professional bodies, especially with regard to training standards and accreditation of qualifications. Government should also build a regulatory framework to permit and ensure that innovators receive a substantial personal share in the financial returns on their ideas and patents (including tax credits to encourage companies to reward their product champions generously).

Letter to the Clerk of the Committee from Professor Peter Day, The Royal Institution of Great Britain (30 October 1992)

I promised a few observations that might be useful to you as briefing material when your Committee meets the Research Councils on 5 November.

My remarks are relevant only to SERC, of which I have been a client, referee, Committee Member and (as Director of ILL Grenoble) a delegate nominee. My knowledge of the way in which the other Research Councils conduct their affairs is quite exiguous, and I am prepared to believe that they approach their job in quite different ways.

My first, and simple observation about SERC is that it is remarkably complex in its administrative structure: the organigramme (as my French colleagues used to call it) refers to Council, Boards, Committees, Subcommittees, Panels, Commissions, Directorates, Advisory Groups . . . (I may have forgotten a few!) Science is complicated, but not *that* complicated. All of this is a mechanism for deciding priorities, and in my view represents the "reducto ad absurdam" of the peer review system. The latter, we all recognise, is (as some politician said of democracy) a poor arrangement, except for all the alternatives. My case is that, in proportion to the funds being expended, it has run riot. Groups of learned, and busy, people travel the country and sit around tables deciding whether a newly appointed lecturer may have £500 to go to a conference in Boston in 1995. That is not efficient.

I propose a radical pruning of the herbaceous border of peer review organisms, and a cull of the paper in circulation, by the following simplifications:

(1) Because everyone knows that the probability of getting support has diminished, PI's (American for Principal Investigators, i.e., tenured academics) react by swamping the system with proposals, so as to enhance the statistical chances of getting something. Why not move towards the NSF norm in which each PI may hold only one grant at any moment, which should cover the entire costs of the research conducted? The latter includes graduate student and postdoctoral stipends, equipment, consumables, overheads.

(2) Responsibility for apportioning resources between manpower, consumables and equipment should be delegated to the researcher, who knows better than a committee what the real needs are. Budget management should lie with the person in charge of the project.

(3) The corrolary of (2) is that the intensity of review shifts from input to output. After say three years the outcome is assessed, and a decision taken on a simplified 3-level basis: level funding, curtail or enhance.

Of course, what I have put down here is the barest skeleton of a new arrangement for responsive-mode funding. But it does represent, in my view, a way out of the morasse of bureaucracy which, if not positively self-serving, acts as a powerful brake on the creativity of individuals and, at the very least, is a great consumer of time and energy.

Letter to the Clerk of the Committee from the Royal Academy of Engineering (3 November 1992)

In reply to your letter to Sir William Barlow dated 21 August, I am enclosing a copy of our response to William Waldegrave's questions. In addition, set out below is a summary of the organisational recommendations which we are submitting to OST.

Main points

1. Science, technology and engineering are inter-related, but not the same.

SCIENCE on its own is not primarily wealth creating. It is necessarily about discovery, analysis and fundamental knowledge (e.g., the characteristics of silicon in the context of electronics).

TECHNOLOGY is the use of scientific knowledge (and engineering techniques) to establish ways and means (e.g., establishing methods for creating integrated circuits using silicon).

ENGINEERING is about design and creation. It uses science based technologies as well as contributing to them, but is about synthesis, processes, holism and the "manufacture", "building" or "assembly" of artefacts. Engineering management is as much an art as a science (e.g., developing usable integrated circuits, the means for their economic production and their incorporation into products).

Science, technology and engineering are interdependent but are certainly not the same or interchangeable and much misunderstanding stems from regarding engineering as a branch of science, rather than a user of it.

It is not true that all investment in the Science Base underpins industry. Some of it does, whilst other elements are contributions to fundamental understanding or investment in national well-being. The element which does contribute to industrial performance and wealth creation should be given greater priority. To achieve this the Government needs an overview, which should be carried out by OST, of all Government funded R&D as a basis for setting priorities and allocating funding accordingly, not necessarily in the same proportions as has been the case historically.

2. We are not satisfied with the present arrangements for the management of engineering research within SERC. The Council is dominated by scientists and academics, the current arrangement of an inter-board Materials Commission, bridging Science and Engineering, is about to be changed with materials becoming part of a Science and Materials Board. We believe this is a retrograde step. Much of the Government support for technology and engineering is through the DTI, including jointly with SERC and industry in its LINK programme and in its support for the SERC Teaching Company Scheme. DTI is currently reviewing its interfaces with SERC. DTI also sponsors the National Engineering Laboratory.

We believe there would be merit in creating a new body to combine all engineering research activities, from basic research to applied technology, including the possibility of major demonstrator programmes and collaboration with industry. In any such arrangement all current sources and levels of funding should be brought together. The task of the new body could be:

> "The organisation of Government funded research in engineering and related technologies, supported by the appropriate science, and the transfer of developed technologies into industry for the good of the UK."

3. There is a lack of national understanding of the importance of technology, engineering industry and wealth creation and their importance to the national economy. The Academy believes that a national awareness campaign is required to redress matters. A relevant model is the way in which the DTI's awareness campaigns about the Single European Market transformed the attitude of industry and commerce. A similar effect on the public perception of industry could dramatically effect both attitudes to the consumption of home produced products and the understanding of prospects for careers in industry.

4. The fiscal climate in this country is not sufficiently supportive of Research, Development and Innovation. Examples are the disincentive of Advance Corporation Tax and the contrasting Australian Tax incentives for R&D which are highlighted in the response to Q8. If industry is to recover and prosper, a much more supportive approach is required.

The Academy would be happy to amplify these points to the Committee if required.

Annex

RESPONSE TO QUESTIONS BY THE RT HON WILLIAM WALDEGRAVE, MP

1. *Why does the UK seem to be less successful than its competitors in translating inventions to the market place? Why is this more so in some industries than others?*

(a) This observation clearly has some substance in the light of the current decline of the UK's manufacturing and construction base.

Amongst many difficulties experienced by UK companies there are a number of factors which inhibit their long-term thinking (and performance), of which the following are important:

The less favourable climate for long-term investment in the UK and a lack of understanding of the problem by the financial institutions.

The lack of government support for crucial near-market R&D.

And, above all—

The absence of an industrial strategy which would clearly establish certain industries as mainstream or essential to the UK's industrial base, i.e., those which add value.

As a consequence of this and the adoption of a "free for all" or "let market forces prevail" philosophy, the UK has lost its technical grip on, or has been forced to close, industries which still flourish in other countries, e.g.,

Shipbuilding,
Machine Tools,
Computers,
Truck Manufacture,
Automobiles,
Consumer electronics,
and others such as rail traction and mining equipment which are going the same way.

In addition, and principally as a result of privatisation, a number of industries have lost their facility to develop prototype equipment on their domestic systems. The availability of a domestic launch pad is essential if UK equipment manufacturers are to sell innovative equipment overseas.

(b) Some of the most successful UK companies are in the pharmaceutical and chemical industries. Of the world top 10 pharmaceutical companies four are from this country. They have a tradition of being run by people with a strong technological background, including well qualified engineers and scientists, and are technology based. High levels of R&D investment coupled with close links to the research community are accepted practice.

In many other sectors of industry, particularly manufacturing, there is a preponderance of company structures dominated by non-technical cultures and over-emphasis on short-term results and dividends at the expense of long-term investment. This perpetuates low spending on R&D and a related gulf between industry and academia.

This widespread weakness stems, largely, from our educational system which encourages very early specialisation instead of a broad grounding to the age of 18. Industry had a poor image and until quite recently attracted few graduates (e.g., ship building, prior to 1970); it was becoming out of date, unprofitable and uncompetitive. In many parts of industry, for most of this century, there have been no formal links to academia, no incentives to create them and little perceived requirement for technological development. Academia has had no desire or incentive to get involved; finance was available from grants, and research activities could be selected with little accountability. Governments have not helped by propping up outdated industry for "employment" reasons, or by taxing "profit" without regard to re-investment.

(c) Major changes in this culture have occurred in the last 15 years but have been only partially successful.

(d) We now have a situation in which much industry, not all of it outdated, has closed, and much else is regressing. HEIs need industrial work and money, industries need new technologies. But the inertia in changing the culture, and particularly the education system, is great. Nationally we are weak with an industrial base that is too small and the cultural links between industry and academia not yet sufficiently well developed. And yet industry has been very largely left to fend for itself. Such major and essential changes in national culture and structure do not necessarily need direct involvement by government but they do need encouragement and assistance. Without such assistance change is too random and too slow. A national strategy is urgently required to encourage and accelerate change.

There is a lack of continuity and cohesion between research (R) and development (D), and government funding of research but not of anything "applied" or "near market", has accentuated this divide which needs to be bridged. There is great confusion over "R" and "D". They are different activities and yet we use "R&D" as a single term. "D" is generally the responsibility of industry, but a development project can run into difficulty or uncertainty which in turn generates research needs arising from near market activities, but the research is not itself "near market", [a term which implies a saleable product]. There is scope for much more pragmatism and less simplistic interpretation of rules, without which we put ourselves at a disadvantage against our international competitors.

Corporate strategy is probably too often dominated by short-term considerations. The present fashion of encouraging large companies to concentrate on a limited number of core activities has led to the disposal of many subsidiaries strong on innovation and in potential. Such disposals have often been to management buy-outs or small groups with inadequate financial resources to fund innovation which can be expensive. Thus these companies tend to shrink and wither away rather than thrive and develop.

Another worrying trend is for large companies to refuse to fund long-term redevelopment or replacement of long running profitable products.

As a result, sectors of British industry such as machine tools, consumer electronics, silicon chips and ship building have virtually disappeared, losing over a million jobs and causing long-term balance of payment costs.

In short, the industrial base is too small and is shrinking. A cultural change is needed and industrial innovation requires more encouragement from government. Without such structural changes the take-up of technological developments is impeded rather than encouraged.

2. *(1) Do we have an agreed measure of the capacity of an industry, or a firm, to innovate?*
No. But innovation without R&D is rare.
So one measure is R&D annual expenditure expressed both in overall spend and as a ratio of sales. Year-on-year trends can be seen and comparisons made.

(2) Do we really know whether our firms are getting better or worse at innovation?
Not in general, although there are many examples of excellent innovation.

(3) Do technology-based innovative firms survive longer? Is the alleged lack of innovation a lack of good ideas, or finance, or what?
It depends on the quality of management. A lack of innovation very often results from a shortage of good management with technical understanding and vision. This is another aspect of the cultural/educational past. But aspects of company structure, financing and attitudes to rates of return and "patient timescales" are relevant.

[The First "Innovation Lecture" by Akio Morita is relevant]

3. *Do we need more or less planning in Government science and technology?*

More, but at the macro level. We need a system which will address national priorities. Not all government funded research underpins the wealth creating industries. Much is for social, environmental or health reasons and some is in curiosity/basic research. This may be regarded as being for the national good, but it is at a cost to the nation. Only a few areas provide spin-off into wealth creation—pharmaceuticals most dramatically. Generally speaking the petro-chemical industries are R&D intensive and are successful. The weakest elements are the manufacturing and construction industries where the base is too small and there is a massive balance of payments deficit. Wealth creation is fundamental because it generates the revenue for everything else. Engineering is a key and neglected area underpinning the whole spectrum of industry. Priority decisions on expenditure and research into generic technologies to underpin these fields could be addressed by the OST in an overview of all government funded R&D, including departmental budgets. If national performance is to be improved, government strategic direction of funding levels is required. At the detailed level less involvement is needed; for example, less bureaucracy is required in allocating university small grant research funds.

4. *Do we get optimum benefit from our international collaborative programmes, especially in the European Community, and do they complement our national programmes well?*

No. We cannot do everything, even on a collaborative basis. We should decide what to get involved in and fund that involvement centrally with periodic reviews. Our current involvement in basic research, e.g., CERN, takes a disproportionate amount of money from the available national funding and the effects are compounded by exchange rate fluctuations.
Engineering development programmes are left largely to industry, unlike the French who often implement government strategic plans to create new enterprises. It is no accident that Airbus Industrie is centered in France and that the UK has a smaller share than Germany or France. [Separate comments have been submitted on the Fourth Framework Programme, which have also drawn attention to the need to maintain the aim of contributing to the competitiveness of European industry. There is little point in investing in more science simply for the sake of doing so and recent UK suggestions for addition to the programme have had no industrial aim]. Co-operation between DTI and OST is essential. There are some successful collaborative programmes. Examples are ESPRIT and EUREKA.

5. *Does the UK get the very best value for money from Government's considerable expenditure on science and technology?*

No. The priorities and balance are wrong. There is a great deal of excellent prestige science, but it is not matched by sufficient usable technology to underpin engineering and industrial developments, innovation and wealth creation.
Much of the government's expenditure on research is directed at areas not intended to underpin industry, e.g., astronomy or archaeology, even if such work is nationally important for quite different reasons. Much is directed justifiably at the environment or the health of the nation. There may be links to industrial success, such as pharmaceuticals but, in the main, such research is undertaken for social reasons, national prestige or contributions to world programmes, and is not intended to be wealth creating. This category of research is necessarily a charge on the nation, albeit an investment in its well being, but not in its wealth. More attention needs to be paid to redressing this imbalance by actively supporting the development of usable new technologies which will create the wealth for reinvestment, including investment in scientific research.

The often heard claim that science research expenditure necessarily all underpins the prosperity of the nation is not true, and can be related to the disparities between the UK's excellent reputation in scientific research and poor industrial performance, compared with Japanese industrial strength despite their much weaker scientific base. This is a question of priorities and targeting. [It is significant that the Japanese are now funding a growing Scientific base from successful industry in order to maintain their technological lead while the UK is finding it harder to maintain science funding from a faltering economy].

6. *Are spending priorities right or would the Government be better advised to spend money in other areas of science and technology than the ones it funds at present?*

The priorities are not right, which is the theme of these comments. Priorities should be:

(a) To develop the science base where it is likely to contribute to improving the technological competitiveness and engineering excellence of UK industry, thereby improving the economy.
(b) To direct funding to the development of technologies applicable to engineering and to industry.
(c) To create, from current disparate activities, an effective range of government funded research organisations, complementary to academia and the private sector, to support (a) and (b) above.
(d) To create a single mechanism to advise government on scientific and engineering priorities across deparments.
(e) To decide what is to be undertaken collaboratively, particularly on Europe, and what nationally.
(f) To influence education and training in science and engineering and the public understanding of the importance of wealth creating industries.

Because of its origins as the SRC, SERC is dominated by scientists and academics. The traditional cultural imbalance is deeply imbedded and the long-established style of meetings is alien to industrialists. The Engineering Board of SERC labours under the disadvantage of being only one of four such Boards. It achieves much but nationally the programmes in industrially relevant "generic" technologies, manufacturing processes and construction techniques lack critical mass and urgency. The recent dismantling of the inter-Board Materials Commission, thereby weakening the interface between new materials and engineering, is an example of a confused strategy.

7. *Does the Government have the right advisory structures at its centre to help it take decisions on priorities?*"

The creation of the OST is a step in the right direction but a revised organisation is needed to replace the existing overlapping activities of ACOST, ABRC and the Research Councils in order to:

(a) Provide advice to Government.
(b) Address the question of priorities across departments and the research councils.
(c) Allocate funds on the basis of these priorities rather than historical precedent of spending pattern.

The two, inherited, advisory bodies now overlap.

The Chancellor of the Duchy of Lancaster should have a single Advisory Board of some eight or 10 members including company chairmen or chief executives from industry and senior academics. Such a Board would have six or seven short meetings a year to provide advice on policy issues and priorities. It would not deal with funding allocations and monitoring.

A second Board will be necessary to allocate funds to the Research Councils in accordance with the priorities determined by the Chancellor. This might be a restructured ABRC without the Heads of the Research Councils as full members so that fully objective views could be taken on the redeployment of funds. Then Heads of the Research Councils would be left to utilise the funds allocated under the control of their own Councils.

8. *How can we best ensure that the strong upward trend in industrial R&D expenditure in the UK will continue and gather pace in the years to come, so that our record is as good as the best of our international competitors?*

We do not believe that there has been a strong upward trend in all areas and some are particularly weak. Much more encouragement is required from government.

However, there are two approaches:

(a) To maintain and enhance the flow of technically literate people into industry, and into all other walks of life—the banks, city, civil service, accounting, etc.—and to develop many more engineers and scientists as broadly based managers in addition to the specialists. This should improve understanding of the need to invest in R&D. Technology transfer is facilitated through people while innovation is achieved through knowledgeable people of vision and drive. All the current post-graduate programmes, TCS, IGDS, the new Eng D, Modular MScs, MBAs for engineer and academic/industry exchanges in both directions, are relevant and important. We must encourage high grade, broadly experienced engineers in industry as leaders of innovation and drivers of R&D, as is the case in Germany.

(b) To encourage companies to invest in R&D by fiscal measures. For instance, full development of industrial processes and products is very expensive, often two orders of magnitude greater than the related research programme. However, international companies based in the UK will continue to think very hard before committing major resources to full development here in circumstances where such expenditure would reduce the liability to UK Corporation Tax below the level needed to offset Advanced Corporation Tax already paid. This drives development, a major component of innovation, overseas and leads to yet more "production only" operations and the dilution of the technology base. The government should encourage the opposite as in Germany where development work attracts incentives.

There are a number of other options which have been widely debated for the fiscal encouragement of spending on R&D and for the follow-on investment necessary for production. The Treasury should be pressed to give priority to such ways of encouraging industrial innovation and expansion to help and facilitate pull-through of new technologies. [The recent Australian White Paper—"Developing Australian Ideas" makes a relevant comparison].

9. *Could the links between academia and industry be improved to encourage maximum exploitation of the science base?*

Yes, by clearly defined co-ordination. The theme for improved industrial/academic links also runs through these comments. Many of the European Community programmes help, as does LINK. The Teaching Company Scheme and related programmes are excellent. The aim should be to create academic-industry links in as many more fields as possible. The Academy does this in a modest way through jointly sponsored Senior Research Fellowships and Research Chairs, through Visiting Professors in the principles of engineering design and through secondments and attachments of various types. This style of programme should be greatly extended throughout the country by every possible means.

The government should also support demonstration plants (with industry and academia) in areas of potential strategic value but with technology which might not yet be profitable. Some environmental and alternative energy projects, such as biomass propagation and conversion, are good examples. The Japanese used this approach to develop clean coal technology which was required for the reintroduction of coal following the oil crisis. They are now world leaders in many aspects of this work.

10. *Is the UK working in areas of basic science which have less marketable derivates than those on which our international competitors concentrate their efforts?*

We are unable to give a view.

11. *Is there scope for improved training opportunities in science and technology?*

Yes. See 8 above. There are many good, relevant schemes but the numbers involved could be increased to national advantage. There is also scope for creation of joint academic/industry research projects and possibly variations on the Fraunhofer/Faraday Institute model. The aim should be to move people through the system into industry, thereby transferring technology, and not necessarily spending a full career in academic research.

12. *What steps do we need to take to improve the status of scientists and engineers?*

Public pronouncements on "the lack of status of engineers" should be discouraged as they simply perpetuate an unhelpful message to teachers and young people. Status is earned not created. There are many very successful and eminent British engineers who are rarely described as such when in senior posts where they tend to be referred to as businessmen, managers, directors, etc. We need to describe them as engineers and explain their roles. This is an aspect of public understanding which needs improving.

Letter from Dr P Collins, Head of the Science Policy Section, The Royal Society, to the Clerk of the Committee (17 November 1992)

I have discussed earlier with you or one of your colleagues the Royal Society's written submission to your inquiry on the policy and organisation of the Office of Science and Technology. We agreed that our submission to you would be based on our submission to the Office of Science and Technology White paper consultation, and I indicated that this would not be available until the middle of November.

We have now completed our work on this and I enclose the full text of our submission, together with a covering letter to Mr Waldegrave which sets it in context.

At the beginning of October we sent you our report on the Science Base, which covers some of the issues that you are now considering.

I hope you find this helpful. Please let me know if you need any more information.

Appendix

Letter to the Chancellor of the Duchy of Lancaster from Sir Michael Atiyah, President of the Royal Society

I enclose the Society's input to your White paper deliberations. This builds in part on some of the points made in our report on the future of the Science Base, which we gave you last July; I enclose an extra copy for ease of reference.[1]

The Society is strongly committed to identifying and nurturing excellence at the level of the individual scientist, in both national and international contexts. This commitment is reflected in our paper, which seeks to put the individual scientist at the heart of science policy.

The Society was very pleased that OST was established and was placed in your charge. We also appreciate the opportunities created by the current consultative process and your wish to examine the fundamentals of the role of science and technology in national life. We stand ready to contribute further to the preparation, or subsequent discussion, of the White Paper should you so wish.

Since your consultation is an open and public one, it seems appropriate for the Royal Society's submission to be made publicly available in due course, particularly since we shall also be responding to the Commons Select Committee Inquiry into the functions of OST.

Perhaps I might add a note about my own personal position as President of the Royal Society and simultaneously a member of ACOST. On a number of important issues the submissions of the Royal Society and of ACOST diverge. In these cases my own views are more accurately represented by those of the Society.

SUMMARY

(i) *The prime role of OST* is to develop and oversee the implementation of a strategic vision of the contribution of science and technology to UK life. The means for doing this include co-ordinating S+T activities across all Government Departments, representing the UK in international fora, maintaining contacts with the private sector and resourcing the Science Base. The effectiveness of OST in meeting these challenges would be greatly enhanced by assigning to it via PES transfer a budget of £100 million (roughly 2 per cent of Government expenditure on R&D) to cover nationally important S+T activities that transcend the responsibilities of individual Departments.

(ii) *Advice to Government* on S+T should be provided by (a) a body on the lines of ACOST able to develop strategic oversight of major national issues, and (b) internal OST mechanisms for determining allocation of resources. The Royal Society, on its own and in collaboration with other Academies through the National Academies Policy Advisory Group, would be willing to provide independent advice and in-depth analysis on specific policy issues.

(iii) *The European Community* constitutes a key element in the S+T environment that needs to be fully incorporated into national policy making. The current approaches to funding the UK contribution to EC research activities and to handling the overheads on EC-supported projects need to be rethought. Serious attention needs to be paid to ways of systematically accessing and exploiting the 95 per cent of global R&D that is conducted outside the UK, including strengthening schemes to enable individual researchers to interact with colleagues in other countries. This is a key responsibility of those concerned with nurturing the UK Science Base.

(iv) *Universities* stand at the heart of the Science Base. Dedicated research institutes, which also play an important role both in the conduct of research and in the development of effective research careers, should be closely associated with universities. The dual support system and the block grant covering both research and teaching are crucial. Any extension of eligibility to compete for Research Council grants needs to be approached very carefully, if it is not to damage universities and the Science Base generally.

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[1] Not printed.

(v) *Elements of the Research Council system* need modification. We recommend a new Research Council to cover aspects of basic research, particularly in respect of the core physical sciences, together with a small number of mission-oriented Councils each covering both basic and strategic research relevant to their missions.

(vi) *Exploitation* is not about pushing the Science Base into neglecting its core mission: it is essentially about creating an environment conducive to long-term thinking and entrepreneurial endeavour.

(vii) We welcome the Government's commitment to expand *higher education.* Institutional diversity must be maintained and enhanced so as to cater for a wider range of students. Reform of education for 16- to 19-year-olds is critical if greater participation in higher education, particularly in science, is to be achieved.

(viii) *Individual researchers of outstanding ability* should be given long-term (5 year) support relatively early in their careers to enable them to become establishhed and to make maximum contributions to research. Consideration should also be given to establising a professional career grade of Research Officer working in support of research leaders.

I ROLE OF OST

1. The role of the OST is to develop, continuously, a strategic vision of the contribution of science and technology to UK life; to promote actions conducive to that vision; and to monitor the effectiveness of those actions. To this end, OST should:

— Co-ordinate Government S+T actions in both civil and military sectors, looking for example at relevance to the strategic vision, gaps and overlaps between or within Departments, international aspects and overall scale.
— Represent UK science at Government level in international fora.
— Monitor S+T supported by the Department for Education and carried out in universities.
— Maintain an awareness of private sector S+T activities.
— Allocate resources in direct support of the Science Base.

2. In addition to responsibility for the former DES Science Budget, we recommend (see *The Future of the Science Base*) that OST have charge of a separately identifiable budget to meet:

(a) Subscriptions to international facilities and programmes, established by intergovernmental agreement, where continued involvement needs to be viewed in a broader context than the functional responsibilities of any one Department/Agency (international collaborations entered into by Research Councils at their own initiative should remain a charge on their own budgets).
(b) Activities transcending the responsibilities of individual Departments that nonetheless are, actually or potentially, vital components of the national R&D infrastructure.
(c) Complementary funding for certain EC-supported research projects.

3. A sum of £100 million (roughly 2 per cent of Government expenditure on R&D) might be allocated for (b) and (c). This would greatly enhance the effectiveness and authority of OST in discharging its co-ordinating role, and make it more able to deliver a coherent S+T policy for the UK.

II ADVICE TO GOVERNMENT

4. The detailed advisory structure needed by OST will depend on what changes are made in relation to the function, operation and finance of the Research Councils. But certain broad principles will in any case apply.

5. First, a body on the lines of ACOST should continue to advise the Government on strategic issues of national importance. Consisting of experienced and influential members from industry, commerce, science and higher education, such a body is well placed to deal with broad issues. However, it is not suited to detailed investigations.

6. For extended in-depth analysis of specific issues, advice should be sought from relevant organisations outside Government. The Royal Society would be willing to provide advice to the OST, or to other Government bodies, as occasion arises. In this context we would also draw attention to the joint action of the British Academy, the Conference of Medical Royal Colleges, the Royal Academy of Engineering and the Royal Society who are offering, through the National Academies Policy Advisory Group, to act as a consortium for providing independent advice.

7. The OST will have to have an internal executive mechanism for distributing the various parts of its budget. It is not clear that a body such as ABRC will be needed under the new arrangements, since Research Councils and other recipients of Science Budget money can bid directly to the OST.

III INTERNATIONAL ISSUES

8. The European Community already plays an important role in many aspects of UK policy. We see this increasing rather than decreasing in the long run. This affects science and technology as much as other areas of public life. It therefore becomes essential to incorporate the EC dimension (and the wider European dimension) into the baseline of UK S+T policy development. This is one of the key responsibilities of the OST.

9. The current approach of funding the UK contribution to EC research activities, and to handling the overheads on EC-supported projects, needs to be rethought.

10. The UK is said to conduct 5 per cent of global R&D, which implies that 95 per cent of global R&D is done elsewhere. Means must be found for identifying and tapping into the best of this 95 per cent if the UK is to optimise its resource base. Such a many-sided task needs an imaginative approach; one important element will be increasing the formal and informal opportunities for individual researchers to interact with colleagues in other countries. This, too, is a matter for OST oversight.

IV ORGANISATION OF THE SCIENCE BASE

11. The respective roles of old universities, new universities and Research Council institutes in carrying our Science Base research need to be thought through.

- The research function of the Science Base should not be isolated from other functions such as teaching, professional development or interaction with the rest of the UK S+T system.
- The natural home for Science Base research is the university, where these various functions can reinforce each other beneficially. Within the university system, research should be concentrated in those departments and institutions best able to do it. Each department and institution should determine its own mission in accordance with capability and opportunity: the new university system should encompass a wide range of different bodies.
- Where research is best conducted in dedicated institutes with full-time research staff, these institutes should be closely associated with a university so as to maximise interchange between them and facilitate personnel management.
- Specialised facilities should recieve the bulk of their funding from fees paid by or on behalf of users. This will help to tie them into changing research priorities.

12. We strongly commend continuation of the dual support approach to funding research in universities, for all the reasons set out in *The Future of the Science Base*. Under the dual support system, money for underpinning academic research is disbursed as one element of the block grant given to each university. This covers many aspects of research infrastructure, including the management of scientific information on the necessary scale and quality, to which we attach some importance. The block grant is constructed out of distinct elements for teaching and for research, and performance in teaching is assessed separately from performance in research. Nevertheless, in accounting for expenditure of this block grant, it is impossible sensibly to separate, in detail, what is spent on research from what is spent on teaching. Any attempt to introduce rigidly separate financial accounting for research and for teaching expenditure would be artificial, administratively expensive and immensely damaging. It would undermine the whole ethos of universities and should be resisted. The OST's co-ordinating role will enable it to ensure that the disbursement of money for research within the block grant is coherent with the rest of Science Base expenditure. Close liaison with the Department for Education and the HEFCs will be essential for this purpose.

13. We are concerned about the notion that Research Councils grants could be made available to any bidder. This is a dubious application of the principle of competitiveness. The responsibility of Research Councils in giving grants is to support the research and training functions of the Science Base, not to "buy" specific pieces of knowledge. The idea of a "free market" in grants, open to all types of organisation, is therefore misplaced—a conceptual confusion between grants and contracts. However, there might be a case for bodies within the normal definition of the Science Base, or even on occasion other public sector grant-aid bodies, competing for grants from the Research Councils, provided they do so in a way that does not discriminate against universities or in other ways act against the long-term national interest. This implies, *inter alia,* that proposals must be priced realistically and not be subsidised from funds intended for other purposes.

14. All Research Councils in varying degrees are seen as having a conflict of interest between supporting their own staff and supporting researchers in universities. This could be mitigated by reducing ring-fencing and encouraging competition between all claimants on Research Council funds. It would, however, be important to ensure that the groundrules were established so that the outcome was in the national interest: this would be a task for the OST.

15. In structural terms, some parts of the present Research Council system suffer from confusion between the mission to support basic research and more goal-oriented missions. In some areas of science it is possible and desirable to combine a strong and effective commitment to basic research with more strategic

and applied work., This approach already works well in parts of our present structure, and it could be extended. In other areas, however, where time-scales are longer and potential applications uncertain, it may be difficult or inappropriate to restrict basic research in this way.

16. For these reasons we would like to see:

(a) A Research Council for some aspects of basic research, particularly in respect of the core physical sciences, with a mission defined in terms solely of scientific excellence and of training in research; and

(b) A small number of mission-oriented Research Councils, including some of those already operating, each covering both basic and strategic research and training, relevant to their missions, and being judged both by internal criteria of scientific excellence and by external criteria of relevance.

(c) Central co-ordination by OST.

17. This would allow us to foster basic research in its own right without separating strategic/applied from basic research. The Research Councils should have a UK-wide remit; separate Research Councils for England, Scotland and Wales are not appropriate, especially if a single block grant approach to university funding is retained.

V EXPLOITATION

18. R&D covers a multitude of different types of activity. At the applied research or experimental development end of the R&D spectrum, it is appropriate to ask fairly direct questions about contributions to wealth creation, though it must be remembered that there is a complex relation between the two and many other factors affect the eventual outcome. The Government's role here is mainly one of fostering an environment conducive to wealth creation, encouraging a long-term approach to competitive advantage and a more entrepreneurial culture at all stages of the process.

19. The role of the Science Base end of the R&D spectrum is different: it is to create options, and to establish a resource of skilled people who can grasp the implications of these options. High quality research by definition deals with the unknown. It cannot be planned or targeted in any direct way. To expect a one-to-one relation between basic science and "marketable derivatives" is to miss the point. The observation that the skilled pursuit of knowledge can lead to exploitable results does not imply that such results should be explicitly demanded from each project. A blanket demand for quantifiable results is a sure recipe for cautious mediocrity.

20. The issues that the Chancellor identifies concerning the UK's ability to derive wealth from its investment in R&D are important. The answer does *not* lie in pushing the Science Base into neglecting its core mission. The UK needs that mission to be fulfilled, and the Science Base is the only way of doing it. Nor, indeed, is the problem one of lack of creative ideas feeding through to, or stemming from, industrial R&D activities. The responsibility for improving the UK's capability for creating wealth from science and technology lies primarily with industry, and depends on its financial and managerial structure. Failure to invest in long-term R&D on an adequate scale distinguishes this country from its more successful competitors. The Government should consider what fiscal or other measures are needed to rectify this situation. There may also be a problem in the area between what the Government sees as a legitimate claim on public funds and what industry is prepared to invest its money in. The Government's unwillingness to get involved in so-called "near market" research might usefully be re-examined.

VI THE ROLE OF HIGHER EDUCATION

21. We welcome the Government's commitment to expand higher education. Greater participation will involve a continuing process of increasing the diversity of students, both post formal education and mature, full-time and part-time. It will also involve achieving greater participation of women, especially in science and technology disciplines. To cater for a wider range of needs, institutional diversity must be encouraged. The Society is undertaking its own study of the reform of the higher education sector and that report, with policy recommendations, is due to be completed in the first quarter of 1993.

22. As participation in higher education increases, the role of the new sector will become increasingly diverse. In addition to supplying a range of highly skilled scientists to staff the Science Base, institutions must encourage a greater understanding of science in those graduates who enter other employment sectors, and provide a flexible curriculum for a wider range of student groups than ever before.

23. We remain deeply concerned that the current arrangements for the education of 16- to 19-year-olds will inhibit the development of mass participation in higher education, and will continue to encourage specialisation of study at the age of 16. The imposition of the "arts/science" divide greatly disadvantages the UK. In 1991, in the report *Beyond GCSE* (enclosed), the Society proposed a Baccalaureate type qualification which would encourage participation, increase breadth of study, and allow a combination of both academic and vocational education. These reforms are critical if greater participation in higher education, and particularly science and its wider understanding in the community, are to be achieved.

VII CAREER STRUCTURE

24. As pointed out in *The Future of the Science Base,* good science is done by good scientists. It is of paramount importance to identify good scientists and to offer them the prospects of a rewarding career in research.

25. Able researchers, identified after one or two short-term contracts, should be rewarded by long-term support. Salary and research expenses guaranteed for at least five years, coupled with rigorous review, would be appropriate. They should be allowed to carry their resources to any approved academic institution, thereby providing more genuine competition for resources and greater independence for individuals. This would give abler scientists the chance to demonstrate their talents and secure long-term appointments, while making HEIs compete for good researchers.

26. It is important that the support of independent individual scientists is clearly distinguished from the support of research projects through normal grant applications. This may require separate administrative structures or channels.

27. Careful attention should be given to ways of enabling women researchers to play a full role in the Science Base. At present it is unnecessarily difficult for women researchers to realise their full potential —an unaffordable waste by any perspective.

28. Progress in science depends on many differently skilled people. For many purposes the professional grade of "Research Officer" can provide a valuable and satisfying career path. The Research Officer, already present in certain institutions, is a competent postdoctoral scientist, though not a team leader. ROs and technicians (qualified to HNC/D or graduate level) should form a core group that is skilled, versatile and employed on a long-term basis. Continuity would depend on an appropriate ratio of core to independent researcher staff reflecting the research work being done. It would be proper to achieve some flexibility across the spectrum of posts.

Memorandum submitted by The Royal Institution of Great Britain (17 November 1992)

Submission to the Chancellor of the Duchy of Lancaster, Minister of Public Service and Science

Enhancing Public Awareness of Science and Technology: the Role of the Royal Institution

AWARENESS OF SCIENCE: A NATIONAL NECESSITY

The Chancellor of the Duchy of Lancaster has indentified the major issues to be addressed in the White Paper he intends to publish in Spring 1993 as the exploitation of science and the application of technology, especially in the encouragement of innovation. These are indeed vital matters, that must be seriously addressed if Britain is to remain competitive as an advanced industrial nation. But behind them lies another, that transcends questions of scientific creativity or technology transfer: that is, the overriding need to develop the widest possible awareness, among all sections of society and all age groups, of the power of the scientific approach to the world we inhabit. It permeates our lives and underpins the entire fabric of contemporary civilisation; without it we would all be cold, naked and diseased. Any national policy for science and technology must contain, as a necessary foundation, the diffusion among the public at large of an appreciation of what science is (equally important is an understanding of what it is not!)

THE "PUBLIC RELATIONS" OF SCIENCE AND TECHNOLOGY

All major organisations and programmes consuming substantial resources necessarily devote a fraction of their budgets to explaining their strategies and actions to those who support them and to the public at large. In the case of the government's programme on science and technology such explanation must proceed at two levels:

- — Pointing out the importance of the scientific and technological enterprise as the necessary foundation of industrial innovation and hence national prosperity.
- — Expounding the activities of particular sectors of the research enterprise, bringing achievements to public view, and successes to the attention of those who might exploit them.

GOVERNMENT AGENCIES

As far as the activities supported by the Science Vote are concerned, all the organisations receiving funds through the ABRC (principally the Research Councils) are active in promoting public awareness of work that lies within their respective remits: each has a Public Relations Unit that issues Press Releases and other publicity material, organises laboratory open-days etc. What of the first of my two subdivisions above?

INDEPENDENT NATIONAL INSTITUTIONS

Three major national organisations spearhead the task of enhancing public awareness of science and technology in general: the Royal Society, the Royal Institution and the British Association. Each has the characteristic that its activities range over the entire spectrum of science and technology, and that it remains substantially independent of government. All are co-sponsors of the Committee on Public Understanding of Science (COPUS) which both serves to correlate the activities they undertake individually, as well as undertaking actions under its own name. Sir Walter Bodmer, the Chairman, has submitted a memorandum to you describing the present range of COPUS activities, and outlining future plans. The present submission takes account of, and builds on, the COPUS document, in respect of the special position of the Royal Institution.

THE ROLE OF THE ROYAL INSTITUTION

The particular strengths of the Royal Institution as a national focal point for enhancing awareness of science and technology are:

Its **independence,** both of professional institutions specific to single fields (e.g., medicine, engineering), and of government bodies (e.g., Research Councils).

Its **reputation,** both as a distinguished centre of scientific research and as the originator of some of the best known schemes for popularising science such as the Friday Evening Discourses and Young Peoples' Christmas Lectures.

Its **continuity,** as a scientific establishment, from 1799, through the era of Davy and Faraday up to the present day, during which it has been associated with most of the landmarks and events in British Science.

Several features distinguish the contribution made by the Royal Institution to the public awareness of science from those of the other two national bodies in COPUS. These are:

The development of the vividly illustrated lecture-demonstration as a medium of public communication, emphasising face-to-face contact with the audience in a "theatrical" context. This tradition, which goes back to the time of Davy, was brought to perfection by Faraday and continued up to the present.

The building from which the Royal Institution operates provides it with an unsurpassed backdrop to its work, especially the Lecture Theatre, which is truly the British "Theatre of Science".

The wide variety of programmes based on live audience participation, especially the lectures and masterclasses in science and mathematics both for young people and their teachers.

Funding the Royal Institution

The summary of income and expenditure in Table 1 reveals that only a small proportion of the Royal Institution's income is derived at present from government sources: in the last financial year between 20 and 25 per cent or (excluding research grant income) a mere 6 per cent. The remainder comes from the Institution's own endowment, donations from industry and charitable trusts, sponsorship of events, etc. In particular, it must be emphasised that donations and sponsorship represent short-term funding, tied to specific projects. Thus, less than 30 per cent of the Royal Institution's income is assured on a long-term basis to meet the Institution's fixed costs such as the maintenance of the building and staff salaries.

The funds received by the Royal Institution from the Science Vote are presently channelled through three routes:

The Royal Society bids on our behalf for funding from ABRC as part of the budget line on Science Education and Promotion in the Royal Society's Parliamentary Grant in Aid (£78k in 1991-92).

The Royal Institution Professors bid competitively with all other academics in HEIs for research grants from the Research Councils (£373k in 1991-92). With industrial research contracts this represents the whole income of the Davy-Faraday Research Laboratory.

The DFE currently supports the Royal Institution Curriculum Enhancement Project (RICE) with a small (£20k per annum) fixed term grant.

Table 1 also indicates expenditure running in excess of income by about 5 per cent, a situation that can only be remedied by a reduction in activities or an increase in income. The former would be most undesirable; the latter is the subject of continuous effort, including a projected Appeal to the public.

A way forward

If the general argument is accepted that science and technology needs a "public relations" dimension to underpin and explain its importance to the citizen, both adult and young, the question arises as to how that theme can be most effectively orchestrated.

Out of a Science Vote of (in round terms) £100 million per annum it seems in no way unreasonable that 1 per cent be devoted to explaining why the other 99 per cent is being spent, and on describing to the wider public how it is being spent. The latter of these two tasks falls within the public relations remits of the Research Councils, but the former to COPUS and its constituent agencies. The COPUS submission to the present consultation round suggests an increase of £1 million per annum to raise the scale of its programmes, of which £200k would enhance actions undertaken directly by its three co-sponsors. To this proposal, with which the Royal Institution is fully associated, and gives its strongest support, we would add the following:

The Royal Institution be recognised officially by Government as a national focal point for activities enhancing public awareness of science and technology.

The Royal Institution be granted direct funding from OST (or ABRC, if it continues to exist) to enable it to take on this role, especially in relation to its building, staff and facilities; a realistic level of support would be one-third of the total budget, excluding research grant income.

In recognition of its focal role the Royal Institution would house the secretariat of COPUS.

Consideration be given to the possibility of the Royal Institution acting as agent for activities relating to the public understanding of science on behalf of OST and/or the Research Councils.

TABLE 1

The Royal Institution of Great Britain

Forecast for the year to 30 September 1992

	£	£
Income		
Government sources:		
Research	373,000	
Schools and Public Understanding	100,000	473,000
Industrial sponsorship		424,000
Investment and endowment income		441,000
Other resources		236,000
Total income		1,574,000
Expenditure		
Research		964,000
Schools programme		381,000
Members		316,000
Total expenditure		1,661,000
Forecast—deficit for year		87,000

Memorandum submitted by the Department for Education (23 November 1992)

DFE funding of research

DFE funding is provided to universities through the Higher Education Funding Council for England (HEFCE) for basic and strategic research and for teaching postgraduate students. The Education Departments in Scotland and Wales provide similar funding for their higher education funding councils. For the purpose of this note "universities" include colleges undertaking research and teaching postgraduate students.

2. The aims of DFE's funding of universities are:
   - The advancement of knowledge.
   - The generation of innovative research which leads to subsequent development and application; and
   - The production of very highly qualified manpower to meet the needs of the economy.

3. A description of the present system of funding for teaching and research and of the new arrangements being introduced from April 1993 was set out in the White Paper *Higher Education: the New Framework* (Cm 1541). The White Paper emphasised the four key principles of competition, selectivity, accountability and plurality of funding sources for university research.

4. HEFCE funding provides the research infrastructure in the universities. Under the new boundary for dual support, universities meet the costs of permanent academic staff and premises for Research Council projects, while the Councils meet all the other costs. The remaining HEFCE funding—which is the majority—is spent on seedcorn research which is not yet ready for support from the Research Councils, and on support for longer-term collaborative research sponsored by charities and industry.

5. DFE believes that such longer-term collaborative research is beneficial to the UK's S&T effort, so long as cost-sharing takes place on the basis of an accurate estimate of full costs and any contributions by universities are clearly identified. Near-market applied research commissioned by industry and Government Departments is expected to be self-financing. Such research has increased substantially in the last decade.

6. The Secretary of State has asked the HEFCE to secure increased accountability for the use of its research funds. Universities will remain free to make their own judgments about the use of funds. Freedom to alter the balance of activity between teaching and research provides important academic and financial flexibility for universities. Funding both teaching and research through DFE not only enables the HEFCE to form a view on the overall financial position of institutions and to monitor their financial health, but also offers universities the freedom to determine the optimal final allocation of the funds as between teaching and research.

7. The cost of postgraduate teaching are shared between block grant from the HEFCE and fees paid by the Research Councils, other external sponsors and students themselves. The UFC's policy has been to hold funded postgraduate places broardly level. The UFC's assessment has been that undergraduate participation should be the main priority. The HEFCE is currently considering its policy in this area.

8. It is for individual universities to set their own priorities for research funded by the UFC and HEFCE. The UFC has monitored the development of planning systems. The recent initiative by the HEFCE to increase accountability for its research funds should lead to improved planning. It will be for the HEFCE to advise on the balance of its funding between teaching and research, and on the distribution of the latter between different areas, taking account of broad national priorities and perceived benefits of past spending.

9. The DFE also funds directly specific research projects which support its own policies for education. The main objective is to obtain information from each project which will help:
   (a) To guide policy decisions that need to be taken.
   (b) To improve the quality of the educational process in areas of policy concern.
   (c) To facilitate the implementation of policy decisions; or
   (d) To evaluate the likely effects of the implementation of policy decisions.

Links with the office of Science and Technology and the research councils

10. The DFE has regular day-to-day contact with the office of Science and Technology over a wide range of issues. The respective interests of the DFE and OST in research in universities mean that policies and practices need to develop in harmony. The DFE's contacts with the research councils come through the Advisory Board for the Research Councils, on which a DFE official acts as assessor.

11. The Higher Education Funding Council for England has its own direct contacts with the OST and with the research councils. These links are reinforced by the fact that Sir David Phillips, Chairman of the ABRC, is also a member of the HEFCE.

Division of funds between teaching and research

12. In considering the HEFCE's proposals for the division of its funds between teaching and research in universities, the Secretary of State will want to satisfy himself that the proposals:
   (a) Provide sufficient funds to support the volume of teaching implied by the Government's student number assumptions without loss of quality.

(b) Enable universities to pursue the aims described above, and to maintain a research infrastructure sufficiently well endowed to support the projects funded by the research councils and others; and
(c) Provide a degree of stability from year to year.

13. At present, during a time of transition to a new framework for higher education, stability in funding is important. The Government has indicated that it does not wish to see the missions of the universities shift markedly. In its latest guidance to the HEFCE announcing a 7.3 per cent increase in funding, it has said that it would not expect the proportion of funds allocated for research to be changed significantly in 1993-94.

Memorandum submitted by the Department of Health (23 November 1992)

INTRODUCTION

1. The Department of Health is responsible for three major areas of research:

Research in the NHS under the recently developed NHS Research and Development (R&D) strategy and programme.
Research for the Department of Health.
Research in Non-Departmental Public Bodies (NDPBs).

The Department also has a wider interest in all health research conducted in England through the research councils, universities and industry.

2. The new post of Director of Research and Development was created in 1990 in response to the House of Lords Select Committee report "Priorities in Medical Research". Professor Michael Peckham took up the post in January 1991, and in April 1991 the new NHS R&D strategy was launched. Preliminary details of the strategy are contained in the document "Research for Health," which was published in September 1991.

3. The Director of Research and Development is responsible for advising the Secretary of State for Health across the range of her responsibilities and interests in research. This includes the NHS R&D programme and the wider R&D strategy which covers the Department's centrally supported research programme, the health R&D of NDPBs, and relationships with the health-related R&D of other government departments, and the European Community (EC). It includes also the Concordat between the Department and the Medical Research Council (MRC) and the relationship with other research councils, the medical research charities and industry.

DEPARTMENT OF HEALTH RESEARCH AND DEVELOPMENT STRATEGY

4. The Department's R&D strategy has four dimensions. These are:
the NHS R&D strategy;
the Department's own research programme;
links with NDPBs; and,
a wider strategy concerning the R&D of other funding bodies;

THE NHS R&D STRATEGY

Objective

5. The objective of the R&D programme is to increase the effectiveness of the NHS by creating a coherent and sound basis for defining strategies in health care, operational policy and management.

Scope

6. The scope of the programme is broad. It covers disease prevention, diagnosis, treatment, rehabilitation and management of disability and chronic illness. It is concerned to develop effective measures of health care need and of health care outcomes. It is also exploring new ways of improving decision making by reviewing and evaluating health service performance on such issues as the integration of hospital and primary care and the evaluation of different forms of health service delivery.

Structure

7. The executive arm of the NHS R&D programme comprises the R&D Directorate of the NHS Management Executive (NHSME) and the Regional Directors of R&D. The advisory arm is constituted through the Central Research and Development Committee (CRDC) established in October 1991. The membership of the CRDC is non-representational, but it covers a wide range of expertise—industry, economics, health services management and finance, public health and epidemiology, health services research, social sciences, medicine, science, nursing, general practice and informed lay participation.

Summary of Approach

8. Under the auspices of the CRDC a broad strategy has been developed within which regions are developing their plans. The approach has been to use short-term expert groups targeted to specific issues, supported by information on such matters as prevalence and costs. The work of each group is associated with a wide consultation exercise. The analysis of problems confronting the NHS, their prioritisation in relation to burdens of disease and the feasibility and likely benefits of research, is being undertaken under six broad headings. These are: disease related problems, management and organisational issues, problems related to different client groups, consumer issues, health technology and research methodologies. Further details are given in the section on priorities.

9. These groups have addressed other issues such as health technology assessment and clinical appropriateness. Emphasis has been given to the development of an information systems strategy (ISS) for

R&D which addresses the need to establish a database of ongoing research, to commission reviews of existing research knowledge and to systematically transfer research findings into practice. International collaboration will be a feature of aspects of the programme, notably in health technology assessment, research reviews and the systematic overviews of clinical trials.

10. In parallel with these central activities regions have prepared and submitted their first R&D plans. These will be developed and refined on an annual basis in order to construct a coherent national programme.

Departmental Research Programme

11. The Department directly manages a range of research work, the three principal components of which are: the Health and Personal Social Services (HPSS) Research Programme; medical devices research; and NHS information technology research.

Health and personal Social Services Programme

12. The Department's research programme on health and social services identifies and funds high priority research for its policy needs. The emphasis is on research in public health and personal social services including community care. Priorities are set and funding its allocated for commissioned research in relation to eight themes introduced in 1992. These are: health status, lifestyles, prevention and promotion, environmental health, social care (adults), social care (children), health interventions and health organisations.

13. Currently this programme supports 373 projects predominantly in the universities. Approximately 30 per cent of central programme funding is allocated for long term support. Currently the Department supports 13 research units, some of which have received funding from the early 1970s. An independent review of funding policy has been commissioned and the report has recently been released. Its recommendations include the creation of a limited number of multidisciplinary reserch centres. A plan for implementation is currently under consideration.

Non-Departmental Public Bodies

14. The Department also oversees the research programmes of some of the NDPBs. Research is used to support the NDPBs in carrying out their statutory or agreed functions and to carry out work commissioned by other funders. These bodies include the Public Health Laboratory Service (PHLS), the National Radiological Protection Board (NRPB), the National Biological Standards Board (NBSB), the Health Education Authority (HEA) and the Central Blood Products Laboratories Authority (CBLA).

Wider Strategy

15. A key objective of the wider R&D strategy is to liaise with and influence other major funders of health related research to bring to their attention the needs of the NHS and the Department and to be aware of growth areas in science. This involves:

liaison with other research funders (the MRC and other research councils, medical research charities, higher education institutions (HEIs) and industry);
liaison with the Office of Science and Technology (OST) and other Government departments;
liaison with the EC and the World Health Organisation (WHO).

Medical Research Council

16. The new Concordat which was negotiated with the MRC in 1991 was introduced in January 1992. As a result, a new board in health services research has been created which will be the focus of expertise in epidemiology, statistics and clinical trials; and two strategy committees, one "needs pull" and the other "science push". The Departmental Research Committee (DRC) has been reconstituted and a sub-committee to deal with MRC business has been created.

Economic and Social Research Council

17. Productive discussions have taken place with the Board of the Economic and Social Research Council (ESRC); these will continue with a view to establishing an agreement.

Science and Engineering Research Council

18. Work supported by the Science and Engineering Research Council (SERC) relevant to the NHS includes the Interdisciplinary Research Centre in Biomaterials. The SERC is participating in the Biomedical Technologies Research Liaison Committee and in the LINK programme with the Department.

Medical Charities

19. The funding of health research in the UK is characterised by the diversity of sources of support. To promote a better understanding of the strategies and priorities of funding bodies, a number of research liaison committees (RLCs) have been established by the Department. The first, cardiovascular disease and stroke, brings together the MRC, the British Heart Foundation, the Wellcome Trust, and the Stroke Association. The Respiratory RLC includes the British Lung Foundation, the Asthma Research Council, the MRC and industry.

NHS and Industry

20. From the outset the R&D initiative was seen as an opportunity to strengthen the relationship between the NHS and industry. This is being pursued in a number of ways. The R&D Director of GLAXO is a member of the CRDC, and regions are being encouraged to include members with experience in industry on their committees. The establishment of an R&D presence in the NHS Supplies Authority has been agreed. The Biomedical Technologies RLC has recently been established and medical devices R&D is being handled by the Research and Development Directorate. The Department participates in LINK (molecular sensors and medical implants) and is an associate member of the Centre for the Exploitation of Science and Technology (CEST). The Department has already indicated its support for the Faraday Centre concept. An NHS Industry Group is being established to bring these various strands together.

HEALTH RESEARCH EXPENDITURE

21. There is no accurate figure for expenditure within England, but total spending by major funders is estimated at £1.7 billion. The largest investor is the pharmaceutical industry which spent approximately £900 million on R&D in 1990-91. The NHS and the Departmental R&D expenditure accounts for £250 million in total. The Association of Medical Research Charities and affiliated bodies spent around £220 million in 1991-92, with additional spending by non-member charities in the region of £20 million. The other major funders are the MRC, (£167 million in 1991-92), and the Universities Funding Council, (approximately £175 million).

22. There are several components to the £250 million expenditure of the Department and the NHS. The Department directly oversees around £35 million, mostly through the centrally commissioned HPSS programme. Research in NDPBs is an important part of the work funded by the Department, and in 1990-91 this accounted for around £28 million.

23. NHS expenditure includes two substantial items. The first is the research component of the Service Increment for Teaching and Research (SIFTR). The second is the estimated proportion of the support allocated to the eight London Postgraduate hospitals. Taken together these items account for about £170 million of the estimated cost to the NHS.

PRIORITY SETTING

NHS R&D Strategy

24. The CRDC has established a priorities working group to advise on the overall strategy for priority setting. As indicated above, key issues for the NHS are being identified under six broad headings by a series of time-limited advisory groups. These groups are provided with relevant information including details of existing R&D and new opportunities arising from basic science and will consult widely within the NHS and with the research community. The priority areas identified will be ranked according to explicit criteria. The first exercise in problem analysis and prioritisation was in mental health, the single biggest cost to the NHS. An expert group was convened in October 1991 and background information assembled on prevalence and costs. After extensive consultation with organisations, institutions and individuals, and enquiry by members of the advisory group, there was a ranking exercise which resulted in the identification of 31 problem areas. In June 1992 bids for support were invited from the research community. There was an overwhelming response: over 470 outline proposals were received. Up to £1 million a year has been allocated to this programme and the detailed submissions of short listed applicants are currently being considered by an independent review group. A second review of cardiovascular disease and stroke in now in progress.

25. Work is in hand on the interface between primary and secondary care, the role of R&D in relation to contracting between purchasers and providers, physical and complex disabilities, and consumer issues. There is a substantial programme of commissioned research on the assessment of health care needs.

26. In conjunction with the Chief Nursing Officer, a nursing research taskforce has been established which will report in December.

Health and Personal Social Services Programme

27. Research within the HPSS programme is commissioned in relation to eight themes: health status, life styles, prevention and promotion, environmental health, social care (adults), social care (children), health interventions, health organisations.

28. Priority themes are agreed by the DRC which is chaired by the Director of Research and Development and made up of senior departmental officers including the Chief Medical Officer, the Chief Economic Advisor, the Chief Nursing Officer, Grade 2 doctors and policy administrators. As well as agreeing priority themes for research, the DRC agrees priorities within themes which accord with Ministerial goals, aims and objectives. Research is only brought forward which fits within the broad theme priorities determined by the DRC.

29. Individual research projects have to be relevant and subjected to independent review by external referees. A new code of practice is being introduced to ensure that all research supported centrally through the Department is recorded, that policy objectives are clearly defined and that peer review mechanisms are observed.

30. "The Health of the Nation" White paper states that "research is essential to any strategy to improve health". Both the White Paper and the NHS R&D Strategy set frameworks within which priorities, measurable objectives and the most effective use of resources combine to provide high quality services to achieve improvements in health. More specifically R&D will be directed to the attainment of targets in key areas and the setting of targets in other areas. A substantial body of work relevant to "The Health of the Nation" is already in hand.

Liaison with the Medical Research Council

31. The MRC supports medical research from basic to applied, and the Health Departments (Department of Health, Scottish Office Home and Health Department, Welsh Office and the Department of Health and Social Services, Northern Ireland) have an interest in the full range of the MRC's research activity.

32. The working relations between the Health Departments (HDs) and the MRC are governed by a formal agreement; a Concordat. This was recently renegotiated and came into effect from January 1992. The new arrangements, which replaced an agreement made in 1981, are aimed at developing an effective partnership for Government funded health R&D in the UK. The new Concordat will run for five years with the opportunity for a formal review after two.

33. The partnership arrangements provide for the MRC and the Health Departments jointly to address ways of meeting the research needs of the Departments and the NHS, and to use their particular skills and experience to best effect in areas of overlapping responsibility. Provision has been made for the MRC to have an input into the development and determination of the Health Departments' research priorities, and for the Departments to have an input into the development and determination of the MRC's research strategies. The agreement is designed to support the scientific and medical communities in relating research activity to the requirements of patients and the population at large.

34. The Health Departments' interest in research, as both sponsors and customers, has two main foci: the needs of the NHS and the needs of public health and personal social services policy.

35. The Concordat provides for a pragmatic and flexible approach to be taken to defining respective roles, ensuring regular liaison and consultation, and where appropriate exploring opportunities for joint funding where there is an overlap of interest.

Office of Science and Technology

36. The Department of Health welcomes the creation of the Office of Science and Technology (OST) and the appointment of a science minister of Cabinet rank. It provides an important focus for the development of R&D in Government. The main effect will be to reinforce co-ordination with respect to wider issues such as the internal market for Government funded R&D, relations with EC research programmes and a range of other issues. The current review of the funding of the science base is an important stocktaking exercise. The forthcoming White Paper on Science and Technology will have a vital role in highlighting the R&D contribution to national economic performance and improvements in health and wellbeing.

37. OST has an important role in co-ordinating UK research in Europe through the official committee structure and with the Office of the UK Representative in Brussels. The EC R&D programme contains several health related research programmes in which the Department has an involvement. These include: the Biomedical and Health Research Programme (BIOMED 1), for which the MRC has lead responsibility on behalf of OST; the Radiation Protection Research Programme; and Advanced Informatics in Medicine. These programmes are funded over the period 1990-94 as part of the EC's Third R&D Framework Programme.

38. There is a considerable future agenda for OST to address. This includes the encouraging the effective exploitation of science and technology, and promoting the role of science among a wider public. This activity involves all Government departments, including the Health Departments.

Co-ordination with other government departments

39. Liaison with other research funders including other government departments is an important plank of the Department's R&D Strategy. As the responsibility for the NHS in Wales, Scotland and Northern Ireland rests with the respective territorial health department, an extra dimension is added to co-ordination considerations when taking forward health research within the UK. To ensure that duplication of effort is avoided the Department of Health and territorial health departments of Scotland, Wales, and Northern Ireland work closely together.

40. The Department's HPSS programme covers England and Wales, with the Welsh Office having member status on the DRC which steers this programme. The NHS R&D Strategy is a strategy for England. The Welsh Office is developing a separate health and social services research strategy which will include the NHS Wales R&D Strategy. The Department of Health and Welsh Office will be working closely together as the arrangements for implementing research strategies in England and Wales are developed in detail.

41. Both the Scottish Office Home and Health Department and the Department of Health and Social Services Northern Ireland attend DRC meetings as observers. The Scottish Office has had well developed strategies for health and health services research for more than a decade, and they are now building on these through their Chief Scientist organisation. The Department of Health and Social Services (NI) expects to publish soon a consultative document for a R&D strategy for health and personal social services in Northern Ireland. The Department of Health attaches great importance to keeping all territorial health departments informed of plans and progress. All territorials contribute to certain MRC programmes and are playing an active part under the new Concordat.

42. The Department liaises also with those other government departments which have an interest in health related research. It has close involvement with the Ministry of Agriculture, Fisheries and Food (MAFF) on food safety research matters. Both have a strong interest across the field and share a joint responsibility. In broad terms MAFF leads on the chemical safety of food, veterinary issues, milk and meat hygiene and the nutritional requirements of the diet, whilst the Department leads on the microbiological safety of food and food hygiene generally as well as clinical nutrition. Within government generally there is a renewed emphasis on nutrition which was prompted by the launch of "The Health of the Nation". The latter has committed Government to signalling the importance of dietary factors in combating major diseases and to enhancing research into the links between diet and health, and into influences on consumer choice. The Government has recently announced the creation of a Joint Nutrition Task Force to co-ordinate the widespread action required to achieve the dietary targets in the "Health of the Nation". It will include parties from inside and outside Government and will be serviced jointly by the Department and MAFF. It is expected that MAFF and the Department for Education (DFE) will have important roles to play in this arena.

43. The Department funds various programmes of research into the health effects of ionising and non-ionising radiation. In this respect, it is guided by recommendations made by the Committee on Medical Aspects of Radiation in the Environment (COMARE). A wide range of departments attend meetings of COMARE as assessors. Following a recommendation by COMARE, the Co-ordinating Committee on Health Aspects of Radiation Research (CCHARR) was set up under the joint stewardship of the Department and the Health and Safety Executive. CCHARR manages projects, funded by both departments, relating to parental exposure to radiation. In addition, the Department liaises closely with the Department of Environment on the issue of domestic exposure to radon. The Radon Policy Group is chaired by DOE, and both departments have been involved in funding an epidemiological study to provide data on the effects of radon in a domestic context.

44. The Department works with the Department of Trade and Industry (DTI) on a number of initiatives designed to promote UK industrial innovation and competitiveness. The Department is involved in the LINK programme, and DTI is involved in the Biomedical Technologies RLC. The Department also assists DTI in considering EUREKA proposals, and in drawing them to the attention of potential participants from industry. EUREKA is a framework for industry-led projects aimed at producing high technology goods and services. It is not an EC programme but 19 countries participate, including the 12 EC member states.

Relationships with the science base

45. The science base contributes to the Department's R&D programme and there is feedback to the science base on public health, NHS and social services problems relevant to research. The most formalised relationship is with the MRC through the Concordat. However, there is input from the biological, physical and social sciences into the CRDC and the RLCs. The sciences outside the conventional medical research field, particularly the various branches of engineering, also contribute to the programme.

46. The regional R&D network will be a valuable development for the NHS and for public health more generally. Through regional R&D committees and the network of contacts of Regional Directors of R&D there will be contributions from, and feedback to, a wide range of basic and applied scientists.

47. The Department's Chief Scientific Officer has joined the Research and Development Directorate. He has contact with the cadre of about 3,000 NHS clinical scientists (these include medical physicists, clinical engineers including rehabilitation engineers, cytogeneticists, molecular geneticists, scientists engaged in tissue typing, immunologists, microbiologists and audiological scientists) as well as with the corresponding technical staff and a variety of other technical officers who assist clinicians in cardiology, respiratory and neurology, renal dialysis and gastroenterology. Clinical scientists have R&D as part of their responsibility and conduct scientific research simultaneously with delivery of clinical services.

48. The role of the scientist in the R&D programme is pervasive. It includes the provision of information on growth areas in science, the development of new methods and technologies, the bringing to bear of scientific approaches to practical health issues and the development of devices and computer-based aids of direct benefit to patients.

TECHNOLOGY TRANSFER

Science and Technology and Health

49. Two features of the current situation concern the pace of change and the origin of health technologies. Not only is the pace of change rapid, but the interval between scientific discovery and practical development is becoming shorter. Rapid progress is being made in constructing maps of the human genome, and at the same time human gene therapy is moving inexorably towards clinical trials. The first clinical gene transfer was in 1989. Three years later, and there are (worldwide) 11 active clinical protocols, nine more approved protocols and more than 12 in preparation.

50. The impact of biotechnology is illustrated by the fact that of the 14 new drugs and biological treatments introduced into medicine in 1991-92 under the category of "fully innovative active substances", seven were new chemical entities and seven were new biological/biotechnology products.

51. A second aspect concerns the flow of technologies into health from fields outside the conventional territory of medical research. An example is the development of non-invasive monitoring of cerebral oxygenation in neonates using near infra-red radiation. This makes use of technology from cruise missile guidance systems, the remote sensing of ballistic missiles, high speed optoelectronics from telecommunications and naval research on techniques of underwater visualisation.

Links with Universities

52. The transfer of technology from universities to industry is not a matter for which the Department has general responsibility. But the health sector is a major industry, and in this sense the close relationship between universities and the NHS, through medical schools and teaching hospitals, provides an opportunity for scientific and technical developments arising from academic activity to be developed and demonstrated in real-life situations.

53. The NHS R&D strategy will encourage close collaboration between universities and the NHS, as well as with the MRC and charities. An important element in these working relations is to ensure that good relevant research findings are used by the NHS.

54. The Department is investigating new ways of facilitating the transfer and development of findings between academe and industry. It supports the concept of Faraday centres as a means of realising the more effective use of scientific achievements.

Links with Industry

55. Industrial developments in science and technology have a relevance to the objectives of the Department's R&D activity. The Department is concerned to promote basic science through its wider discussions about technology transfer for health service application. The application of developments in basic science are important both to the NHS and to the economic and industrial sectors. There are important general lessons from missed industrial opportunities such as monoclonal antibodies and CT scanners, and from the successes of the pharmaceutical industry through scientific innovation.

56. The Department talks to the research community and the NHS, often the main customer for research work in the health field. Ensuring the NHS is an "informed customer" and that industry knows their needs will help to facilitate transfers of appropriate technologies. The improvement of links with industry and other research funders is an important aim of the NHS R&D strategy which should, in turn, assist the transfer of technology. The research director of GLAXO, Dr Sykes, is a member of the CRDC and Regional Directors of Research and Development are being encouraged to develop links with industry as they establish regional committees and develop their R&D structures.

57. There are links with industry through the NHS Supplies Authority and Medical Devices Directorate Evaluation Programme as well as DTI-related initiatives such as the LINK programme and CEST, which seeks to indentify scientific developments which may become commercially significant. Plans are being actively pursued to develop an NHS-Industry Group to improve collaboration between the NHS and industry.

58. The NHS ISS will provide an important avenue to alert and inform industry of research in progress which may lead to commercial possibilities and to the simplification and standardisation of intellectual property right negotiations.

Pharmaceutical Research and Development

59. The Department of Health is responsible for the Government's relations with the pharmaceutical industry. Although through the NHS it is the industry's dominant customer, purchasing about 95 per cent of all ethical medicines sold in the UK, the Department's Pharmaceutical Industry Branch is also the sponsor within Government for the industry, in the same way as DTI is for most other industries. Whilst sponsorship does not encompass specific interventions, it does involve understanding the needs and concerns of the industry and ensuring that they are given due consideration within Government.

60. The pharmaceutical industry is a global industry. All the major companies operate world-wide, and most have a large proportion of their sales and their activities outside their home country. The UK is a

relatively small part of the world pharmaceutical market—about three per cent of sales—but it is a favoured location for both production and research. About five per cent of world pharmaceutical production and eight per cent of world pharmaceutical R&D is located in Britain. Of the 88,000 people employed in the pharmaceutical industry in the UK in 1991, about 18,000 were engaged in R&D of whom at least one-third were science graduates. The industry spent over £1 billion on R&D, more than 16 per cent of sales, in 1990. Products developed in the UK include four of the 10 best selling drugs in the world, including the world best seller, ranitidine (Zantac).

61. The reasons for the location of pharmaceutical R&D in the UK are varied. The world pharmaceutical industry operates in English, and language is an important factor. The tradition of pharmaceutical R&D in the UK means that there is the critical mass of scientific knowledge and expertise necessary for innovative research. The long tradition of clinical research and the structure of the NHS provide a good environment for the conduct of both large and small scale clinical trials. The standing of the British scientific and educational infrastructure and the research base in the University sector are important. All the major pharmaceutical companies have close links with British universities, and especially with Cambridge, Oxford and London.

62. One further reason is the Pharmaceutical Price Regulation Scheme (PPRS). This is a voluntary agreement whereby the Department, as the major customer, regulates the profit the industry may make from sales to the NHS. One of the allowable costs which the industry may offset against profits is expenditure on R&D. Each company is granted an R&D allowance according to the extent of its investment in R&D in the UK. On average the allowance for the industry as a whole is a about 30 per cent of sales. Within the pharmaceutical industry as a whole companies spend about 15 per cent of sales worldwide on R&D, so the allowances in the UK acknowledge the greater contribution to R&D made here through the prices paid for drugs by the NHS. In addition, the extent of investment in R&D is one of the factors taken into account in determining the target profit for each company, within the range of 17 to 21 per cent return on capital. In these ways the PPRS is designed to provide some encouragement to companies to retain or develop their UK R&D activities.

Memorandum submitted by The Scottish Higher Education Funding Council (23 November 1992)

Response to consultation on Science and Technology White Paper

INTRODUCTION

1. This paper has been prepared in response to the Chancellor of the Duchy of Lancaster's invitation to provide comments to be taken into account in the preparation of the Office of Science and Technology's forthcoming White Paper. In inviting interested parties to comment, the Chancellor identified a number of significant areas to be considered: this paper concentrates on those of particular relevance to the Scottish Higher Education Funding Council.

THE COUNCIL'S ROLE IN THE FUNDING OF SCIENCE AND TECHNOLOGY

2. The Scottish Higher Education Funding Council attaches great importance to its responsibilities for the funding of research in higher education institutions. The Council fully supports the Government's desire that the general funds available to support research activities in higher education institutions should be distributed selectively by reference to quality criteria; and that there should be increased accountability for the way in which those funds are used. In exercising its responsibilities, the Council will wish to collaborate closely with other organisations, particularly the OST and the Research Councils, to ensure coherence and compatibility in approaches to the public funding of research in Scotland. The Council sees its arrival on the Scottish scene as a great opportunity to help exploit more effectively the known strengths and international standing of the research community in Scotland for the benefit of higher education generally and, particularly in relation to Science and Technology research, for the good of the national economy.

3. The Council sees the future structure of public funding for research as central to achieving value-for-money from the Government's expenditure on science and technology. Under the dual support system, universities receive public funds for research through two main channels: from the Universities Funding Council (and in future the three territorial Higher Education Funding Councils) to provide broad underpinning for their research activities: and more targeted funding, usually in the form of specific project grants, from the Research Councils. The funding boundary between these two streams has been shifted recently to enable the Research Councils to pay a greater proportion of project overhead costs and the associated transfer of funds to the Science vote will be completed in 1994-95. An assurance has been given by the Government that the transferred funds will be used in support of research in higher education institutions. The White Paper "Higher Education: A New Framework" (Cmnd 1541) published in May 1991 endorsed this plurality of public funding channels for research in higher education and the Council strongly supports this view.

4. The Council is convinced that the dual support system will continue to operate well under the three new territorial Funding Councils. Its extension across the whole higher education sector will enable research funding to be directed selectively to those institutions best placed to use it effectively. The fact that the premises and staff whose costs the Council's research funding will support will also usually be involved in teaching makes it sensible for grant-in-aid towards their cost to come from a single source. The work underway by the Funding Councils to ensure greater accountability for the use of research funds will increase cost effectiveness while exposing any undesirable cross-subsidisation. With its responsibilities for both teaching and research funding in institutions, SHEFC will be able to take an overview of the financial position of institutions and ensure value for public money, especially at the complex and important research/teaching interface. The Council will also be able to ensure a reasonable measure of stability in the distribution of public funding between institutions whilst responding to and indeed initiating and facilitating desirable changes in the balance and emphases of activities.

5. In relation to its research funding responsibilities, the Council envisages operating a broad strategic steering role using where appropriate the levers available within its funding methods, for example to determine the broad balance of funding across different subject areas; to encourage collaborative activities among institutions and with other research organisations; and to avoid wasteful duplication. Within the broad framework of UK scientific policy, it will be open to the Council to take into account the needs and potential of the Scottish economy to help inform future decisions about the balance of funding across different subject areas.

6. In terms of the types of research to be funded, the Council does not recognise clear-cut lines between applied, strategic and basic research and will wish to hold open the option of providing a measure of funding to help underpin the further development of those research groups in Scottish higher education capable of high quality applied research. The Council shares the concern expressed in many quarters of industry and academia that the balance of support between basic, curiosity-driven research and strategic/applied research funding needs to be carefully reviewed to ensure the optimum benefit from public investment for the national economy whilst retaining the less tangible, but nonetheless important, cultural and academic benefits of fundamental research activity, whether in science and technology or elsewhere. We will be co-operating with the other Funding Councils in seeking improved means of measuring the quality and quantity of research output and developing performance indicators for the system as a whole.

7. The Council will wish to work closely with other interested organisations, particularly Scottish Enterprise and Scottish business organisations, in promoting and facilitating the transfer of science and technology know-how from higher education institutions to industry. The Council also recognises the major role of the higher education system in providing an adequate supply of scientists and technologists for industry and will be considering to what extent it might continue to steer funds preferentially for both under-graduate and post-graduate student places towards these areas.

RESPONSES TO QUESTIONS POSED

8. Against this background, the Council's response to those questions which touch upon its responsibilities are as follows:

- On the question of **planning in Government science and technology**, we do not wish to express a view about the arrangements within central government but we do see a role for the Scottish Higher Education Funding Council to exercise a broad steering role for research in Scottish higher education, working in close consultation with the Research Councils and other advisory bodies and funding sources.
- On **Government advisory structures**, our only comment is to support continuation of a UK-wide framework for the funding of specific projects and major facilities on a competitive basis, operating within the wider context of EC and other international research activities where the UK make a financial contribution. This UK-wide framework should, however, reflect adequate regional and disciplinary interests for example in membership of Research Councils and other interested bodies.
- On **spending priorities**, it does seem right to take an overview of the balance of public funding among different subject areas within science and technology and to play to the UK's strengths: in the context of higher education research, while recognising the need to leave discretion to institutions to choose the direction of research we also see a role for the Council to exercise a broad strategic steer in deciding the balance and concentration of funding. This might enable support to be directed towards areas where Scotland or the UK in general has or can develop an international "competitive advantage".
- On **value-for-money**, we believe there is considerable scope within our own responsibilities for improvement by increased selectivity in the distribution of funds by reference to quality criteria and by improved accountability for the way in which funds are spent: to this end, we will work with the other HEFCs to develop improved accounting systems and performance indicators for research funding. We also believe that the balance of funding among applied, strategic and basic research needs to be carefully reviewed to ensure that public investment in research is sufficiently geared towards the needs of the national economy. We support the continued use of peer-review by the Research Councils to distribute their funds on the basis of quality. If they were to deal with a wider range of clients, for example including Government research institutions, it would be essential to consider carefully the possible impact on higher education and the need to avoid sudden and potentially damaging changes in the level of public funding support for higher education research: research is a long-term business and we must do nothing to endanger the substantial core of high quality research capability within the higher education system which it has taken so long to build up. This might seriously damage our ability to sustain first-rate research in priority areas. "Open" competition for Research Council funds should be matched by open competition for Government-sponsored R&D, with Government research institutes competing on an even basis with other providers of research.
- On **training in science and technology**, as noted above we will be considering to what extent funds might continue to be steered towards undergraduate and postgraduate education in these areas. Funding for teaching will in part be determined by quality assessment of teaching and learning at both undergraduate and taught masters degree levels. The Council will take such factors into consideration. The Council will also work with the Research Councils in developing its approach to funding in support of postgraduate research places in institutions to ensure that account is taken to strategic aims in science and technology at national level.

CONCLUSION

9. The Council welcomes the Government's intention to publish a White Paper on Science and Technology and the opportunity to contribute during the preparatory stages. The White Paper will deal with important and complex issues of central importance to the economic and cultural well-being of all parts of the United Kingdom and the Council looks forward to being involved in further consultations about the way forward. The Council sees itself as an essential and integral part of the network of public funding sources for science and technology research and will be very happy to work closely with other organisations to maximise the benefit of that investment for the future.

THE SCOTTISH HIGHER EDUCATION FUNDING COUNCIL

Background:

The 1992 Further and Higher Education Act (Scotland) required the establishment of a Funding Council for higher education institutions in Scotland. This parallels the establishment of Higher Education Funding Councils (HEFCs) in both England and Wales.

Established on 1 June 1992, the Scottish Higher Education Funding Council (SHEFC) is responsible for all the university institutions in Scotland which formerly came within the scope of the University Funding Council, a UK-wide organisation, and the other higher education institutions in Scotland which were grant-aided by the Scottish Office Education Department. There are currently 25 qualifying institutions throughout Scotland.

Based in Edinburgh, the Council will have an annual budget of circa £400 million, and will have a projected staff of eighty. The Council must be fully operational by 1 April 1993, and at that time must have published a detailed Management Statement.

Responsibilities:

The principal responsibilities of the SHEFC are:

- To advise the Secretary of State for Scotland on the needs of the sector.
- To distribute grant provided by the Secretary of State to institutions in the sector.

The Secretary of State for Scotland has outlined the Council's remit and specific responsibilities in a public letter to the Council's Chairman dated 3 June 1992.

These include instructions on the monitoring, modelling and analytic functions of the Council in the performance of its wider duties. In these, the Council will be examining all areas of higher education in Scotland, from the demand and quality of teaching and research, to the efficiency of financial management and administration within individual institutions.

As a general philosophy, the Council is to identify areas where change is needed, and to play a leading role in bringing that change about. It is a proactive organisation, with policy formation as its core.

Organisation:

As a start-up organisation, the structure of SHEFC has been provisionally drawn-up in accordance with its functions. The activities of the Council are broken down into the areas of Policy/Operational functions and Domestic/Administrative functions, with each area co-ordinating to make the most efficient use of information and staff.

Within the Council there are five main divisions:

- **Quality Assessment** responsible for advising the Council on the quality of teaching in institutions within the SHEFC sector.
- **Policy,** the core division of the Council, responsible for policy development and liaising with the Funding Division and the Financial Appraisal and Monitoring Division in the creation of funding methodologies. Responsible for the recommendation of change within the sector.
- **Funding** responsible for the creation of funding methodologies and the negotiation of annual budgets for the SHEFC as a whole. Divided into four sections: Research Funding, Teacher Funding, the Capital Funding and Estates Management Branch, and the Statistics Unit.
- **Financial Appraisal and Monitoring** concerned with the financial aspects of the Council's relationships with institutions, and internal audit of the Council.
- **Secretariat/Administration** concerned with the running of the Council itself and its executive, divided into six sections: Press and PR, Information Systems Management, Personnel, Accounting, Accommodation and Office Services, and Secretariat Services. It will also be responsible for the provision of legal advice.

Staffing:

The Chairman of the Scottish Higher Education Funding Council is Professor Jack Shaw, CBE, who holds the post part-time, in addition to his involvement with the Bank of Scotland. The Chief Executive is Professor John Sizer, CBE, seconded from Loughborough University Business School. Other key appointments include Paul Brady, Director of Planning and Implementation, and David Wann, Director of Funding, both formerly with the Scottish Office Education Department, Jim Donaldson, Director of the Quality Assessment Unit, formerly Chief Inspector for Higher Education in the Scottish Office Education Department, and Dugald Mackie, Secretary to the Council, formerly of the University of Strathclyde.

Given the need to be fully operational by 1 April 1993, recruitment for SHEFC is intensive at this period, with the priority given to positions essential to the establishment of the organisation. Individuals recruited are on fixed-term contracts, to reflect the start-up period of activity of the Council, and many are on secondment from other organisations and institutions.

Letter from Professor M Gibbons, Director, Science Policy Research Unit, to the Clerk of the Committee (24 November 1992)

Further to my telephone call with John Dresner I have now had an opportunity to consider your request that I make a contribution to the evidence being submitted to your Committee on the subject of the proposed White Paper on Science and Technology. You asked, in particular, for my comments on the sort of advisory system which ought to be put in place to advise the government on scientific matters and for any observations I might have about the appropriate structure to aid the effectiveness of a Minister of Science to operate in such fora as the European Council of Science Ministers.

Overall, I welcome the proposal to reconsider the organisation of British science and have tried to respond positively. As will become clear, however, from the short paper, enclosed herein, I have the view that profound changes are underway concerning the conduct of scientific research at the forefront of such areas as materials science, computer science, and bio-technology. These changes are being gradually introduced by the best scientists and reflect, more than anything else their research requirements. I do not believe that the challenges they present can be met by rearranging the existing structure, however cleverly it may be done. Excellent research is now carried out at many different locations in many different institutions around the world. The key requirement for the UK is to play a full part in what is now a globally distributed process. The structures needed to engage in a distributed knowledge production process are differnt from those which are currently in place and which assume that the most important and relevant research will be at home, so to speak.

I hope that the attached document which outlines some of the ideas concerned with recent changes in the production of scientific and technological knowledge will be helpful to your Committee in its deliberations. The developments cited have implications for our understanding of how science is carried out and, consequently for the development of policy in this area. I have tried to be brief but, on re-reading the text, I fear I may have overdone it. If any of what I have written interests you, or if you would simply like clarification, I would be pleased to expand it.

The future of science and technology in the UK and the Government role in it.

Scientific and technological knowledge is coming to be produced in new ways. A new mode of knowledge production is emerging and it is characterised by a cluster of attributes, rarely present in their entirety in any specific situation, but which tend to be associated with one another in ways that distinguish it from the more traditional, "linear", disciplinary, internal, modes of producing knowledge. The features that distinguish the new mode of knowledge production are, to some extent, a matter of shifting emphasis. The point to be noted is that these changes are taking place along a number of dimensions, that they have a degree of coherence and that when they occur together, they constitute a distinct way of carrying out research. There is no suggestion that discipline-based research has outlived its usefulness, or that it will disappear altogether, though in certain circumstances both might obtain. At the present time, both modes of production co-exist, but rather uneasily, because in certain fields the locus of creativity, the manner of is pursuit, and criteria of excellence seem to be shifting. The co-existence of two distinct modes of production set particularly difficult problems for policy makers and for those responsible for managing research in the universities and government laboratories, because it raises in acute form the question of the balance between the two modes. Throughout what follows it is important to resist the temptation to identify the emerging mode as a species of applied science or strategic research. It is not. It is a new form of "scientific" knowledge production with distinct methods, criteria of theortical relevance, and specific forms of organisation. The new mode of knowledge production considerably blurs the conventional distinction between pure and applied science and calls into question the effectiveness of policies which assume that the discovery of knowledge to be institutionally separate from the context of its application.

The key attributes of the new mode of knowledge production are: that it is produced in the context of application, that it sets up new—transdisciplinary—forms of theory and practice; that it is a heterogeneous activity; that it is carried out in a diversity of organisational forms; that it develops hand in hand with the possibilities contained in new instruments and that it requires a much expanded peer review process to ensure quality control.

Some policy implications. The purpose of describing these attributes is to indicate that in certain "frontier" areas many different types of expertise, from many different institutional backgrounds, and geographical locations are involved. This activity does not have to be planned. It is the outcome of largely professional judgments about "where the action is and who the best people are to work with in attacking particular problems. From this follows, immediately, the need for a fresh policy perspective and for new perspective on the nature and extent of the national science base. A new perspective is needed because, if some of the best science is being developed in the interstices between existing institutions as has been indicated, then policies which are formulated primarily in terms of supporting what goes on inside institutions will lack effectiveness, if they are not downright obstructive. If it is the intention to use the science base to strengthen economic performance, then universities and the researchers who work in them need to become more active participants in what is a much more collaborative form of knowledge production.

The upshot of this would be to create considerable ambiguity about the function of the "national" science base. The strength and relevance of that base will be measured more by its international connectivity, than by the numbers of Nobel prize winners that it produces. The contemporary context is increasingly less one in which scientists and industrialists are moving on separate tracks. The employees of the most productive firms belong to overlapping networks with, and work on similar problems to the ones which occupy the best scientists. Policy needs to recognise that this knowledge is now distributed widely across the globe, that it is increasingly produced in flexible temporary structures involving scientists and technologists from many different countries and that access to these activities is on the basis of expertise alone.

For policy makers this will require recognising that the role of government should be concerned neither with picking winners nor with various forms of "environment setting" *laissez-faire* that advocate "sowing a thousand seeds so that one flower may bloom". Both approaches are now outmoded because so much of the best science is carried out in the context of application and those who are not part of the context soon find that they have difficulty following the conversation. The best researchers in university and industry have seen the point. The key question is whether the institutions that support science and technology in the UK can become more effective players in this process. To stand a chance of competing internationally, the UK Government must firstly, become a more active partner in the management of a **distributed knowledge production system.** Its role must be that of "honest broker". Its key goal should be to lower institutional barriers and encourage linkages with this distributed process. And secondly, government will have to interact with this distributed system not only on the supply side encouraging UK participation in collaborative ventures of various kinds, but on the demand side, ensuring that sufficient comparative advantage can be "created" to underpin the competitiveness of British goods and services in international markets. Clearly, there is much more involved here than is usually comprised by the term technology transfer. In particular, the traditional approaches to identifying ownership of intellectual property are still constrained by a view of knowledge as institutionally self contained. The situation becomes much more complicated when user and producers of knowledge are continuously involved in its creation.

The proper management of a distributed knowledge production system requires that UK policy makers engage fully, environments which are characterised by the presence of a shifting number of actors but where no one is in clear control of the process. In this situation policy and implementation in a sense evolve together. This is a complex process, and describes to some extent the situation that faces Science Ministers when they meet in the European Council of Science Ministers. It would also describe the context within which a future European Research Council would operate. Getting value for money out of EC collaborative ventures is far from being an automatic process. It requires constant resourcesfulness from those who function as brokers in the complex world in which knowledge is produced as the result of the effort of many different actors. Paradoxically, the management of a distributed knowledge production process involves both less and more participation by government, less, because government must give up its predilection for "picking winners" and more because it must work to append the science base to those networks, consortia, and schemes which seem to hold out the greatest prospect of supporting UK industry in an environment in which scientific talent is continuously being reconfigured to attack new sets of problems. Only government can be relied upon to maintain this perspective consistently, over time. There is no short cut to continuous engagement. Success is likely to turn on particular combinations of scientific and technical resources with managerial resourcefulness.

Finally, there is the question of the sort of advisory system that is appropriate to a distributed system. It will be clear from what has been said above that the advisory process must be as dynamic as the knowledge production process itself if it is going to be effective. This means the end of generic advice systems and argues for a decentred system that is much broader in terms of competences. Government, in a decentred system should acquire the expertise it needs at the appropriate levels on a case by case basis and deconstitute it when the job is done. Many more actors need to be drawn into the advisory process and this carries with it an additional burden for management. Yet, just such a flexible advisory process constitutes one element of that managerial resourcefulness that was referred to in the last paragraph. On the surface, then, there seems little point in institutionalising a hierarchy within the advisory apparatus. Sound advice depends upon competence, and today, competence depends upon being where the action is. Alas, that site is continually on the move, as are the scientists, engineers, industrial managers, etc. who really know what is going on.

In conclusion, it might be worthwhile reiterating Zipf's Law of development. It is to the effect that the scientific advance is the result of the efforts of 5-10 per cent of practising scientists. Heretofore, these scientists have been housed within disciplinary structures and their discoveries could probably be described as individual achievements. According to Zipf's law a similar small number of individuals working in the new mode of knowledge production are sufficient to advance the frontiers in fields such as bio-technology, computer science and nano-technology, though the particular contribution of individual genius may be harder to identify. Any discussion of the reorganisation of UK science can ill afford to neglect this development, even if it were to remain a relatively small part of overall scientific activity.

Letter and memorandum submitted by John Akker, acting General Secretary of the AUT and Geoff Woolf, General Secretary, NATFHE (24 November 1992)

The Association of University Teachers together with the National Association of Teachers in Further Education welcome this opportunity to provide evidence for your inquiry into the policy and organisation of the Office of Science and Technology.

While the enclosed document deals principally with the traditional universities which receive the majority of the HEFCE grant for research, both AUT and NATFHE welcome the creation of a single body which will oversee all science issues and hopefully enhance the public perception of science in general. We are committed to improving the image of science and since universities not only provide science with human resources, but also employ approximately 20 per cent of the nation's R&D staff, more positive recognition of the latest developments in university research should lead to greater interest in science as a career.

In an effort to further this aim, the enclosed document has two main sections addressing, in the main, questions 2, 4 and 5 as well as touching on other areas. The first looks at the issue of accountability and the second section covers staffing issues.

1. ACCOUNTABILITY

In recognition of the many demands placed on Government funding, AUT/NATFHE appreciate that universities must be accountable, and seen to be so, for the money they spend on research. Since many observers may be unaware of universities' contribution to basic research, there is a tendency to view it as something of a financial "black hole". This rests on a misunderstanding of the nature of basic research which, far from being ill-defined, is just as clearly organised and as capable as being accounted for as applied research projects. There is no necessary difference in accountability frameworks nor would we wish there to be any presumption of different standards of accountability.

The importance of basic research should not be underestimated. It is an essential complement to other specific research projects and to industrial R&D.

AUT/NATFH support a forward looking assessment of research which will give universities the funds they need to complete their research properly. In particular, we support the development of the so-called level playing field whereby universities and research councils would compete on a quality rather than a cost basis. The full cost of any research project is made up of direct labour costs, other direct costs such as travel, computer time and indirect costs such as administration and library expenditure. At present, universities fund the difference between the real cost of basic research and the basic research (R) element of the Funding Council grant. That subsidy is no longer possible or desirable. In 1988-89, we believe the subsidy of £205 million accounted for one third of the money allocated for research in the UFC grant, thereby depleting research resources available for basic research.

Similar problems exist with overseas funding. In 1984-85 research funding from EC and other overseas sources accounted for 6 per cent of the total specific recurrent income for universities. In 1989-90, EC sources alone accounted for 5 per cent of the total with other overseas providing a further 6 per cent. However, without adequate matching funds from the UK government, universities have once again to subsidise their involvement from their limited resources. This is obviously not the way to encourage UK participation in international collaborative programmes.

We want to end these subsidies by means of full costing. We strongly support the Dual Support system but believe "DR" should comprise all non-externally funded costs. However, the present trend towards real reductions in the research grant which continued in the 1992 Autumn Statement will do nothing to see the implementation of this policy. Despite a £10 million increase for 1993-94, factors such as increased international subscription costs and inflation translate this money into real cuts in research council spending and a continuation of the policy whereby universities are forced to seek subsidies and have to find the balance of research expenditure from other sources. The result of this is often a tendency towards highly specialised work to achieve short-term goals instead of a more innovative long-term approach which could fuel major advances in knowledge and its application. This consequent reduction in opportunities for university researchers to engage in basic research and scholarship is a source of deep concern to our members and cannot be in the long-term national economic interest.

2. STAFFING ISSUES

Britain faces a serious problem in that firstly, we have a lower proportion of scientific staff than many other advanced industrial countries and secondly, this proportion is stagnant (0.1 per cent compound growth rate in 1988). The 1990 OECD Science and Technology indicators show that the proportion of researchers in the UK's labour force is well behind that of the USA, Japan and Germany.

The AUT and NATFHE hope that the Office of Science and Technology will, as the central body, take overall responsibility for ensuring an adequate supply of scientific manpower. However, we believe that this will not be possible until the underlying problem of poor working conditions is addressed. Much of that problem stems from fixed term contracts.

In October 1990 the AUT and the CVCP signed the jointly negotiated *Good Employment Practice*. This document sets out guidelines for improving the working conditions of contract research staff. Defined by the USR as full time university employed academic staff engaged solely in research but with funding not wholly university financed, these contract researchers are becoming an increasingly important feature in the UK's university system. As is shown below, there are no signs of this trend reversing:

Full-time staff not wholly university financed (GB)—research only:

Percentage increase 1984-85 to 1989-90	*42.0 per cent.*
Percentage increase 1988-89 to 1989-90	*7.4 per cent.*

The *Good Employer Agreement* offers a number of practical solutions to the problems faced by researchers working on short and fixed-term contracts, mainly related to career development, training, status and pay. The document covers in detail conditions of employment, the research environment and career development and training. It allows for career progression without loss of pay by means of progression through the research staff salary scale; the use of bridging funds between contracts to ensure continuity of income; portable pension rights between universities. A copy of this document is enclosed for your information.[1]

The poor perception of a UK research career, largely due to career insecurity, is undeniable. In 1985-89, 45 per cent of researchers left either to go overseas or to leave higher education altogether, largely as a result of dissatisfaction with career opportunities and the opportunity for better work conditions, including pay (see attached report[1]). Not only is Great Britain losing young qualified scientists and engineers who represent an important investment of national resources, but also many respondents to a questionnaire carried out by the Royal Society and the Fellowship of Engineering stressed that it was frequently the "best" researchers who went abroad thus increasing the debilitating effect on future UK research.

Costings prepared by the AUT and agreed with the CVCP show that of the 33 recommendations in the Good Employer, only five involve any extra cost to external funding bodies. In total these extra costs would add barely half of one per cent to the non-UFC-funded research staff pay bill. A copy of the full costings is included.[1]

To date, the research councils have refused to endorse it on the spurious basis that it was a matter for the institutions. Their refusal is being used by some Vice-Chancellors to avoid implementing the document.

A *singly overarching* body responsible for Science, capable of taking an overall view of staffing issues is badly needed. We look to the OST to be that body, to provide national ratification of the Good Employer Agreement and to develop a UK R&D staffing policy to provide for the future needs of the country.

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[1] Not printed.

Memorandum submitted by the Department of Transport (26 November 1992)

INTRODUCTION

1. The Department is responsible for Government policies on shipping, marine safety, civil aviation, freight transport and the registration of road vehicles throughout the United Kingdom; and for highways, road safety and public transport in England. The territorial Departments have responsibility for highways, road safety and public transport in Scotland, Northern Ireland and Wales, but as far as possible common standards are used throughout the UK.

2. The Department plans to spend about £40 million on R&D in 1992-93. The objectives of the Research and Development (R&D) carried out by the Department of Transport (DOT) are to:

- Support the formulation and implementation of the Government's policies on highways, road safety, public and freight transport, marine safety, shipping, civil aviation and their environmental impact;
- Support the discharge of statutory duties relating to standards and safety; and
- Support purchasing decisions taken as highway authority for trunk roads and motorways.

3. The Department is directly responsible for managing the national road network in England. Findings from the Department's research in relation to trunk roads and motorways are made available to local highways authorities for use on the local road network. The Department is not directly responsible for other aspects of infrastructure provision. As a result DOT R&D is complemented by the research spending of other public bodies:

- The *Civil Aviation Authority (CAA)* on aviation safety and air traffic management.
- *British Rail (BR)* for railways.
- *London Transport (LT)* through London Underground Ltd and London Buses Ltd.

DESCRIPTION OF PROGRAMME

4. The Department's R&D is almost entirely of the applied variety and is made up of a series of programmes each geared to meeting specific responsibilities. The financial allocations that follow all refer to the current financial year 1992-93.

5. R&D in the Department's *Highways, Safety and Traffic Command* has an allocation of £30.4 million, and breaks down into four main areas as follows:

(a) *Road and Vehicle Safety (£13.9 million):* The main objective of this programme is to contribute to the target of reducing road casualties in Great Britian by one-third by the year 2000 (compared with the average for 1982-85). The programme includes research on vehicle safety, on road user safety, and on environmental issues such as vehicle emissions.

(b) *Engineering Policy (£11.5 million):* Improving value for money in all civil engineering and road construction and maintenance. The main issues concern the structural safety of bridges and earthworks, road design aimed at reducing congestion and improving safety, the durability of road pavements, reduction of the environmental impact of road construction and the optimisation of whole life costs.

(c) *Network Management and Maintenance (£3.1 million):* Tackling congestion and providing value for money by making more efficient and safer use of the trunk road and motorway network. The main issues are improving the efficiency of maintenance management, traffic management and control systems and providing better information to drivers.

(d) *Highway Policy and Resources (£1.9 million):* Development and maintenance of the methods for planning and evaluating trunk road schemes, including traffic, economic and environmental appraisal.

6. *The Urban and General* programme has an allocation of £4.2 million. It is concerned with the problems of urban transport and congestion (including the roles of public transport and traffic management), research on road pricing, inter-modal issues and transport facilites for the disabled.

7. The *Marine Directorate* has allocated £1.3 million for two main areas of research, into:

(a) Safety of shipping and life at sea.

(b) Reduction and control of pollution, particularly from oil spills, in the marine environment.

8. The *Transport Security Division* has £2.2 million for research aimed at improvements in security for passengers and freight. It concentrates on three main areas: equipment, human factors and systems. The research is chiefly directed to aviation but some work also serves other modes.

9. The *Civil Aviation Directorate* includes £0.3 million for research which complements R&D carried out by the CAA. These include certain aspects of aircraft safety; and the environmental effects of aircraft, particularly noise and emissions in the upper atmosphere.

10. The *Chief Scientists's Unit* has an allocation of £2.5 million. This covers the Department's contribution to transport research projects, involving collaboration between industry and the science base,

funded under the Government's LINK initiative; "seedcorn" research at the Transport Research Laboratory (TRL) to maintain its long-term vitality; and roads research which (for reasons of policy, climate, soils, geology or traffic requirements) is being managed by the territorial Departments to reflect the full range of conditions on which UK policy and standards should be based.

How priorities are set

11. The Department follows the "customer-contractor" principles formulated by the late Lord Rothschild. Each Directorate listed in paragraphs 5-7 above has a Directorate Research Committee (DRC) (two in the case of Marine Directorate) which meets between two and four times a year. The main purposes of these committees are to develop a strategy for research reflecting their policy and operational needs, to formulate a research programme to service them, and to agree priorities for allocation of resources.

12. Where appropriate, DRCs include cross representation from other such committees. They are also developing sources of expert advice drawn from outside the Department either through membership of the DRC or in the form of a separate advisory body. These arrangements are designed to ensure that the Department maintains a broad perspective when establishing priorities within its R&D programmes.

13. A Departmental Chief Scientist was appointed in January 1992 to exercise overview of all the Department's R&D programmes. His remit is to advise Ministers and senior officials about the scale and balance of Departmental R&D programmes. The Chief Scientist is a member of each DRC.

How the creation of the OST may affect the setting of priorities

14. Because the Department's R&D is in direct support of the Department's business, the main effect of the establishment of the Office of Science and Technology (OST) seems likely to be to reinforce co-ordination with respect to broader policy issues such as intellectual property rights, and the internal market for Government funded R&D. Some of these may have implications for Directorate R&D programmes, but they seem unlikely to affect programme priorities significantly.

Funding through Research Councils

15. The applied nature of the Department's research requirements means that Research Councils in many respects provide complementary support for basic research, education and training. This process is facilitated by the assessors from DOT appointed to particular "peer review" committees. The main link is with the Science and Engineering Research Council (SERC), joint sponsors of the LINK Transport Infrastructure and Operations Programme. The Department has also provided financial support for a Review of Transport Research and Education as co-sponsor with SERC and the Economic and Social Research Council. Research Council Institutes may occasionally also serve as contractors although in recent years such expenditure has not exceeded £0.1 million per annum.

Co-ordination of R&D activities with other departments

16. The Chief Scientist's Unit is the focal point within the Department for contacts on R&D matters with the Office of Science and Technology (OST), other Government departments, and the European Community (EC).

17. The main links are with:

(a) *The Department of Trade and Industry (DTI)* which provides complementary research funding and support for innovation to manufacturers of transport equipment aimed at improving UK industrial competitiveness; on EC R&D programmes relating to transport; on research into alternative fuels; and through the EUREKA programme.

(b) The *Scottish, Welsh and Northern Ireland Offices.* The territorial Departments are invited to provide members for relevant Directorate Research Committees so that their needs can be reflected in developing priorities in the DOT programmes.

(c) The *Department of the Environment (DOE)* on issues of global warming, local air quality and land use.

(d) The *Ministry of Defence (MOD)* on a wide variety of issues, including application of military technology for transport such as navigation and communications at sea, suspension dynamics and electromagnetic interference. Senior officials in both Departments are discussing how best to improve the process by which knowledge of defence R&D relevant to the civil transport sector can be made available to the Department of Transport.

Letter and Memorandum from the Institution of Civil Engineers (26 November 1992)

WHITE PAPER ON SCIENCE AND TECHNOLOGY

The Institution welcomes the appointment of William Waldegrave, MP, as a Minister within the Cabinet having responsibility for Science and Technology. This co-ordinating role between the various Government Departments that have responsibilities for areas of science and technology, together with the recognition that science and technology are vital to the economic health of the nation, is seen as a major step forward in improving the UK's competitive position.

For many years the Institution has been very concerned at the low level of investment in research and development by the UK construction industry, particularly in design and construction methods as opposed to construction products. This is despite the fact that construction comprises 8 per cent of GDP and builds all the infrastructure necessary for the country to function. The reasons for the very low investment have been examined in a number of reports published by this Institution and others. However, to those within the industry they appear to have gone unheeded by Government.

Whilst we have outstanding successes on the world scene in civil engineering and architectural design, the industry is under threat from overseas competition, both at home and abroad, and there is a huge negative trade gap in construction products which has been as high as £2.5 billion per annum. It is an industry that the country must not allow to deteriorate and diminish through lack of both basic and near marketplace research.

The reasons for construction's lack of success in attracting investment in research, centre on the fact that it does not own its products since it provides a service for clients, and in any case improvements in design and constuction techniques are not amenable to patents or other forms of intellectual property protection. As it is the clients rather than the construction industry which benefits from any R&D, it is not surprising that firms in the industry have no direct incentive to invest in research.

In order to show that the Institution is taking this underfunding seriously and to inject new life into a perennial problem, we have established the ICE R&D Enabling Fund, which is intended to act as a "pump priming" mechanism. I am very pleased to say that our members, individuals not corporate bodies, responded very well to an appeal to create this fund and we expect the Fund to continue to attract voluntary contributions of around £97,000 per annum. The existence of this Fund and the fact that it has attracted a wide variety of applications for awards, demonstrates both a need for research and the solution.

It is also our intention to bolster this effort on behalf of the UK construction industry, by seeking additional funds from the DoE to match both those raised by the ICE and industry, as we believe it is vital for the private and public sectors to work in harmony. In particular, we would like to see the DoE change its strategy for R&D away from a dominance of pre-normative research towards more collaborative research to support the industry.

We recognise the vital importance of the dissemination of research results; not only does the Institution publish a large number of research journals and proceedings of conferences, but in collaboration with research and commercial organisations, it is in its third year of publishing a quarterly newsletter, called Research Focus, which is circulated free to 80,000 chartered civil and building engineers. Technology transfer is also, we believe, highly effective via Teaching Company Schemes which provide close links between industry and HEIs.

LINK schemes are in principle an ideal vehicle for the construction industry as they bring together a collection of interests in a similar way to research club schemes, but there has been insufficient support from the DoE to encourage their wider development in the construction industry.

The Institution is concerned that primary and secondary education should give greater emphasis to the teaching of science and mathematics, and we look to a successful outcome of the current review of the technology curriculum, to attract more graduates into teaching these subjects. The Institution's Local Associations are active in this area by providing speakers and visitors for local schools.

It is important that we attract higher calibre students into science and technology and greater enthusiasm would be generated if State scholarships were introduced on a selective basis for potential high fliers.

In terms of identifying problems and contributing directly to research and technology transfer, I think you will agree that the Institution has made a major contribution. In the vast, complex and uniquely fragmented construction industry however, even this is not enough. Further steps are necessary and we look to Government to take a lead. Mr Waldegrave's consultation paper is a most welcome step therefore and I enclose our detailed comments and recommendations.

The Institution of Civil Engineers

Proposals for a White Paper on Science and Technology

RECOMMENDATIONS

Long-term and fundamental research has to be funded by Government. By its very nature, research of this kind is far from the market place and will not be undertaken by the private sector (see enclosed report[1]: A National Agenda for Long-term & Fundamental Research for Civil Engineering in the UK).

2. **Technology and engineering must be given extra resources.** We support strongly the views expressed recently by Sir John Fairclough who would wish to see "much of the public money that finances the science base being applied to relevant research". This is particularly so for the construction industry which represents 8 per cent of GDP and which builds all the infrastructure on which the wealth-creating ability of the nation depends.

3. **The decision-making machinery for the allocation of public funds for Science and Technology needs a thorough overhaul.** As an example, there is not a single construction industry representative on ACOST despite the importance of that industry to the wealth and the fabric of the nation.

4. **Technology transfer mechanisms such as Teaching Company Schemes need to be expanded significantly.** There is insufficient liaison between industry and research/academia; the value of such liaison has been expressed cogently by Sir John Fairclough who states that: "without this mutually reinforcing process, the academic community will be tempted to undertake work that may bear little relevance to exploitation by companies with investment in the country".

5. **A long-term structure needs to be established to develop a national strategy for Research and Development.** This structure should include industry, research organisations and Government. The driving force for the national strategy should be a long-term view (i.e., where we want to be in 10-20 years time).

6. **Government policies should stimulate innovation.** Investment in research should be encouraged through tax incentives and through pre-qualification for tender lists.

7. **The work of the Construction Industry Sector Group must be continued.** If Government is serious about trying to improve the UK's competitive position, this work must be adopted by a Government Department without delay.

8. **The target for R&D funding by clients, designers and contractors should be 1 per cent of turnover.** Despite the relatively low level of investment in construction research (conducted by both private and public bodies), it is managed and disseminated extremely well. The organisational framework for research in construction is therefore both secure and efficient and it is capable of being expanded when funds allow.

DETAILED COMMENTS

1. NATIONAL RESEARCH STRATEGY

The UK's lack of success in translating innovations to the marketplace is due to the absence of a national research strategy, a relatively poor level of government funded R&D, economic "short-terminism" and the isolation in separate compartments of HEI research centres, industry and government. By contrast, Japanese industry and government work closely together. This is not the case in the UK, certainly not in the construction industry. From time to time Government issues guidance and limited funds for R&D and then puts the shutters down, hiding behind the theory that it must not interfere with industry.

The UK does not take advantage of the pool of talent available, given the low proportion of engineers and scientists in the Civil Service. We are all working for the UK and detailed collaboration and understanding between industry and Government must be encouraged and increased. Similarly, there should be increased contacts between academia and industry, particularly through Teaching Company Schemes and Faraday Centres, to their mutual advantage.

2. FUNDING FOR SCIENCE AND TECHNOLOGY

Future funding for science and technology needs to be determined by strategic need for the future rather than constrained by past patterns. Priority should be given to areas of research shortfall, as judged by national need, rather than prestigious projects or where there is already significant research activity. There should be some diversion of funds from pure science to technology. Where there will be a clear yield from applied research to the benefit of UK, funding should not be withheld by government or funding councils on the narrow view that all near market R&D must be funded by industry. This applies particularly to construction, which is vital to wealth creation, to meeting the social and quality of life challenges and in improving the environment. Present funding policies do not take account sufficiently of human and national needs.

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[1] Not printed.

3. Planning

We note that the White Paper will "deal with organisational questions" in the main. However, we are suffering under a surfeit of organisation reviews and planning, notably those by SERC and HEFCE. In fact, researchers and industry need less planning. Innovation will ignite spontaneously, given the right environment, provided it is not suffocated by bureaucracy.

4. Advisory structures

The UK does not, in our view, have the right advisory structures, resulting largely from the absence of detailed collaboration between government, industry and the research funding councils. In addition, we have far too many reviews, most of which are ignored, whilst the fundamental problem is that we as a nation spend far too little on research.

It should also be recorded that the analysis and statistical work done by the NEDC for the Construction Industry Sector Group must be taken up by some government office. It is unrealistic to say that industry must undertake these tasks itself, particularly with such a fragmented industry as construction.

5. Competitive tendering

A further factor restraining the growth of industrial R&D, which may be peculiar to construction, is the UK's tendering system where the lowest price counts for everything. Secondly, there is no recognition by clients in the private or public sectors, of investment in R&D. This results in totally inadequate margins with no funds for R&D and a lack of work continuity from which companies could gain advantage from innovation. Add to this the adversarial nature of the construction industry and its fragmentation into a large number of separate businesses, with design normally separated from execution, and we have a formula for disaster.

This is a situation that has developed mostly over the last few decades driven on largely by "short-termism" but also by government procurement policies. It is in marked contrast to the oil and gas industry where the Offshore Supplies Office, established by Government, takes account of the amount of research undertaken by companies when prequalifying bidders for exploration licences.

A further factor is that in many of our competitor countries, companies experience considerable continuity of work from major clients. In the UK, the highly unstable workload in construction acts against the recruitment and retention of the best people.

6. Technology transfer

Dissemination of the results of R&D, including the translation into applicable forms, is as essential as R&D itself and is funded inadequately within construction either by HEFCE, SERC, industry or government departments directly. Very little is known about how research results are transferred into economic benefits; government could help here. There is no shortage of ideas from the engineering profession but the industry is too dominated by the "short termism" of the city.

7. International collaboration

International collaborative programmes are of doubtful benefit because of the considerable (non-productive) resources necessary for the administration. It would be preferable to increase the degree of subsidiarity such that the Community was responsible for co-ordination only, with funding provided through national governments.

8. Industrial R&D

There is no strong upward trend in industrial R&D expenditure in the construction sector, for the reasons highlighted above.

9. Training

Training opportunities in engineering research are totally inadequate. The salaries of Studentships and Research Assistantships are so low that relatively few good UK students are attracted to such posts, resulting in too high a proportion of non-UK students in research posts and an inadequate number of research trained personnel in industry. This will not change until remuneration is increased and good technologists are rewarded adequately. The simple answer to this is that if you want good people you must pay them accordingly. If this is not recognised then we are only tinkering with the system and we shall need another White Paper in five years' time to find out why we are continuing to decline internationally.

10. Academic staff

If the Government wishes to improve the links between University and Industry then the burden on academic staff in strong research departments must be lessened. The Engineering Council recommended a student/staff ratio of 8:1 for departments with a strong research base and 11:1 for those with a weak base. However, most departments are now operating at overall student/staff ratios of 15:1. At present, engineering academics are struggling to survive in relation to lecturing, tutoring design, carrying out research and the ever increasing burden of bureaucracy (much of which is serving no useful purpose).

Letter to the Clerk of the Committee from Professor John Knill, Chairman of the Natural Environment Research Council (26 November 1992)

Thank you for your letter of 19 November concerning the submissions by ACOST and ABRC to the Chancellor of the Duchy of Lancaster. I enclose the NERC submission to the Chancellor from which you will note that my Council takes a different stance from that adopted by ABRC with regard to the re-arrangement of Research Council structures; I dissented personally from this aspect of the ABRC submission. We stress the importance of the maintenance of the interdisciplinary mission of the environmental sciences and thereby implicitly reject both the removal of the terrestrial and freshwater sciences from NERC's portfolio into a Biology and Biosphere Reseach Council, and the creation of a Geosphere Research Council.

I do not wish to comment at length on the relative merits of the ABRC and ACOST documents as I was privy to all the debate within the ABRC but know nothing of the background thinking which lead to the ACOST submission. I believe that both documents have started from different positions as to the issues which need to be addressed, and how the perceived problems should be solved. ABRC offers an adjustment of the current structures which are largely driven by the need to deliver excellence in science and technology, whereas ACOST is more radical, providing opportunity for greater intervention into priorities by industry and by government. I have no doubt that both could be made to work in principle, although the ACOST proposals would need greater adaptation before they could operate as effectively as is clearly intended. The choice between these two, or any other alternatives, must be determined by one's diagnosis of the depth of the ill which needs to be cured.

The NERC submission, along with those of the other Research Councils, will be put in the public domain by OST some time next week. I should be grateful if you would protect its confidentiality until then.

Consultation on the Science and Technology White Paper

Submission from the Natural Environment Research Council

SUMMARY

- The UK has, within NERC, a multidisciplinary focus for strategic planning of the environmental science base and for securing its delivery. The ever increasing concern with environmental issues and the knowledge of the complexity and integrated nature of environmental systems argues strongly for the retention of a Research Council with a clear cross discipline environmental mission.
- Questions of balance dominate the delivery of S&T: between different areas of research; between responsive and targeted research; between research in HEIs and research institutes; between national and international programmes; between vocational MSc and postgraduate research training. There will be no one correct figure for any of these balances. They have to be managed according to the circumstances prevailing at the time. This does not, however, negate the preparation of a national strategic framework for the delivery of UK S&T. Indeed we believe it is important to develop such a framework base on a 5 to 10 year timescale. The most appropriate structure for the delivery of S&T should be determined in the context of that framework.
- Government will need independent advice on the longer-term strategic aims and objectives for UK S&T right across the board. The development of effective and credible advice will require a significant commitment of time from a small number of highly regarded academics, industrialists and economists, who should be appointed in a personal capacity and who should consult widely and openly.
- Improving recruitment to the skills base is a major topic for consideration. A start needs to be made at secondary or even primary school level. Here, the interest of children and teachers in environmental topics can be used to develop an interest not only in environmental science but also in science more generally. Similarly, at undergraduate level, environmental examples can often provide an effective, highly relevant vehicle for teaching more general scientific concepts.
- Unsoundly based environmental policy and regulation can impose an unnecessary cost on industrial competitiveness. Government and industry needs independent advice from the S&T community on the basis for regulating the impact on the environment and for meeting those constraints with minimum cost to UK wealth creation.

INTRODUCTION

1. The Natural Environment Research Council (NERC) welcomes the opportunity to respond to the Chancellor of the Duchy of Lancaster's consultation on the way forward for UK Science and Technology (S&T). The Chairman of NERC has had an opportunity to contribute to the wide-ranging response to this consultation developed by the Advisory Board for the Research Councils (ABRC). The Council of NERC has also responded to the House of Commons Select Committee inquiry on the policy and organisation of the Office of Science and Technology (OST); a copy of that response is attached.[1]

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[1] See Minutes of Evidence p. 41.

2. This paper first focuses on a number of issues central to the support of S&T. It then highlights the contribution of the environmental sciences and NERC as a mission-led Council, in order to display the strengths of the present arrangements. Finally it looks at the Research Council structures and the present advisory system for S&T, and explores options for enhancing the strengths of present systems. The paper represents a consensus view of members of NERC Council. Where there has been dissent, then the majority view is recorded.

CENTRAL ISSUES

3. The aims for spending on S&T must remain the advancement of knowledge and technological capability through excellent science, the development of the skills base through training, and the application of both knowledge and skills to help achieve economic, social and cultural benefits.

- *Scientific excellence:* Peer review is still the best means of judging excellence and ranking competing bids for the support of basic research. Judgments on strategic and applied science, which includes the long-term observation and survey activities so essential to much environmental research and assessment, also take equally rigorous account of the national need and the potential for application and/or exploitation.
- *Science focus:* The UK should not expect to be a major player in all fields. It should play to its strengths and, where appropriate, play a major part or indeed take the lead internationally.
- *Strategic balance:* Science which is highly relevent to public good issues or to improving economic performance may be different in character to basic research which is breaking the scientific mould. But both can be equally demanding intellectually. Although not necessarily mutually exclusive, when they compete for finite resources decisions have to be made about the overall balance between them. The UK scientific community should be involved in those decisions.
- *Flexibility:* New scientific opportunities and changing strategic priorities demand a flexible approach both from funding agencies and from scientists and technologists, and a plurality of funding mechanisms. A satisfactory balance of properly funded tenured and fixed-term appointments in UK research institutions and in Higher Education Institutions (HEIs) will provide the flexibility to develop new science both by building on experience and bringing in new skills.
- *Skills base:* A flexible and multi-level approach to pre- and post-employment training is needed to respond to changing employment demands. S&T has to be an attractive option for schoolchildren.
- *Exploitation:* The successful transfer of knowledge and technology from the science base to the wider community, for the economic and public good, requires customers with a strategic vision as well as effective marketing by the science base. Direct contract research, collaborative research and training, and special enabling mechanisms all have a role to play to cater for the different needs of customers.

THE ENVIRONMENT MISSION

4. The case for a focus for UK environmental science and independent assessment of environmental issues gains strength with time. NERC's unique and holistic view of the natural environment from a S&T point of view enables it to ensure that the UK contribution to the international effort aimed at improving understanding of the earth systems—which are, of course, integrated—progresses on those fronts where we have particular strengths.

5. The advancement of knowledge of the natural environment and its complex interactions offers scientific challenges of the highest intellectual quality. **It draws on all the basic scientific disciplines.** As the science has developed, so it has become increasingly important to bring the various strands together and develop the **integrated multidisciplinary approach needed to address so many environmental issues.**

6. NERC fulfils its mission to provide the country with a strong base of high quality environmental science and expert manpower through the skilled deployment of various funding mechanisms, both in its own research institutes and in the HEIs. The Council supports:

- unsolicited individual environmental research and training proposals of the highest intellectual quality as judged by peer review (by NERC responsive mode grants, studentships and fellowships);
- individual proposals of equivalent quality solicited by NERC to address a strategic area of importance and timeliness to science and/or to the nation's interest (by NERC Special Topic grants and studentships);
- centres of special expertise in HEIs within a defined area of work (by NERC Units and Centres);
- long-term research, observation and survey programmes and associated developments in instrumentation, methodology and data handling, to improve understanding of the environment and of environmental processes, particularly those that are slow or difficult to resolve (by NERC Institutes or through multi-agency initiatives such as the Environment Change Network); and
- multidisciplinary teams drawn from many UK scientific institutions to focus by means of an agreed scientific plan on a particular scientific question (by NERC Community Research Projects (CRPs)).

7. It is Council's experience and advice that the national requirement for S&T is best achieved through the **flexibility offered by such a variety of funding mechanisms.** It is important that no one mechanism comes to dominate the use of resources. Striking the correct balance at any one time, and maintaining the flexibility to shift resources to change that balance, if it is needed, is one of Council's key functions.

8. Support through Research Council Institutes (RCIs) provides an **important base of longer-term strategic research and survey** which needs to be maintained in the national interest. Customers from UK Government, the private sector and overseas governments see the expertise within NERC research institutes as a valuable resource and already commission a wide portfolio of research and survey. Initiatives aimed at further promoting the relevance and potential for application of the spectrum of NERC science are continuing at all levels within NERC.

9. Whilst environmental science has traditionally been seen as being of primary applied importance in relation to caring for the environment and enhancing the quality of life, inputs to wealth creation should not be underestimated. Such inputs may be direct, in traditional areas such as resource assessment and management and waste management, and indirect, through sound science underpinning the development of sensible environmental policy and regulation. Wealth creation in the UK depends in part on the competitiveness of UK industry. Public concern for the **protection of the environment as expressed through regulation** (often initiated from Brussels) **is a constraint to industrial production and competitiveness.** Such regulation has to be scientifically and technically informed and credible. In addition, industry itself needs to draw on the UK S&T base in order to equip itself to meet these regulations without losing its place in the market.

10. Much environmental science is pursued internationally through formal and informal bi- and multi-lateral associations. NERC provides a national focus for the more formal contacts, and also for UK contributions to the major global environmental science programmes (e.g., those within the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP)). **Decisions on funding participation in these major programmes take due account of strategic science priorities and UK national strengths.** Thus a major UK involvement may be developed in some programmes such as the World Ocean Circulation Experiment (WOCE), with little or no participation in other programmes such as the Tropical Oceans and Global Atmosphere programme (TOGA). The only subscription-based environmental programme, to which NERC contributes on behalf of the UK, is the Ocean Drilling Program (ODP) where a subscription is paid towards the running of a Drill Ship.

11. European environmental science and survey programmes are increasing in importance. NERC has always been particularly concerned to encourage the UK environmental science community to exploit the opportunities offered by European Community funding and to ensure that the EC priorities for research funding as far as possible reflect our own national priorities for European collaboration. We initiated the NERC Brussels Office in the early 1980s to provide a liaison service between the UK environmental science community in NERC and the HEIs and Commission officials, and we continue to support the Office which has now expanded to serve the interests and constituencies of all the Research Councils and the British Council. NERC has also acted as as a focus for putting together a formal input to Government from the environmental science community on the content of the Fourth Framework Programme.

12. NERC and its research community are also seen by Government and others as a source of **independent advice on environmental science issues.** The Council is regularly asked to provide advice to government departments; to Select Committees both on environmental science issues and on more general issues of science policy; to the Royal Commission on Environmental Pollution; and to international commissions and conventions, for example the Montreal Protocol (a BAS scientist discovered the Antarctic ozone hole) and the Rio Conference. The link with government, albeit as a non-departmental public body (NDPB), and NERC's wide ranging contacts with the environmental science community has also enabled it to mobilise appropriate expertise and provide advice and support at politically and militarily sensitive times. The middleman role of the Research Council in the assembly of such advice from the scientific community and its ability to manage people in its own research laboratories (i.e., change their priorities quickly in the national interest) should not be under-estimated.

Research Council structures

13. We believe that a little recognised strength of the UK's present portfolio of five Research Councils is that at any one time one of them is likely to be in the public eye and thus in a position to promote the cause of S&T and to attract young people to S&T. Their interest in the environment needs to be translated into an interest in basic science as a skill with which to address the environmental challenge.

14. Much is made of the present day "boundary problems" between Research Councils, and suggestions are made for changes in structures and responsibilities. However, **both science and the environment are seamless.** The current boundaries between Research Councils are bound to create interfaces of interest (e.g., atmospheric sciences between NERC and SERC, biotechnology between MRC, AFRC, SERC and NERC, land use between NERC, AFRC and ESRC) but then so will any boundary. If one accepts that boundaries are inevitably artificial, then a good case needs to be made for changing the current boundaries and creating new, and possibly greater, interface problems.

15. In 1988 the ABRC convened a Committee chaired by Mr J R S Morris (now Sir Richard Morris) to review the responsibilities of the Research Councils for the Biological Sciences; it went beyond this remit and, having rejected the case for a separate Biological Research Council, recommended the formation of a single National Research Council. In 1989 NERC published its response to the Morris Report. In this response, NERC made some suggestions for achieving better co-ordination between the Councils by strengthening the resolve of ABRC to provide better co-ordination and encouraging better day-to-day interaction between Research Councils. This is the pathway that was chosen by Government. Management of activites at the interfaces between Research Councils has improved significantly in the last three years. Now, in 1992, one can conclude that inter-Research Council co-operation is no longer a major problem. That is not to say that there are no interface problems, rather that there is now the will to resolve them.

16. Most importantly, however, the NERC response emphasised the need to retain a mission based environmental Research Council with a multidisciplinary focus. This remains the NERC position. We have seen no evidence which would lead us to change this view. On the contrary, developments in environmental science are increasingly dependent on a cross discipline integrated approach. To lose what has been achieved to-date would be a highly retrograde step.

STRENGTHENING THE ARRANAGEMENTS FOR STRATEGIC SCIENCE

17. NERC is concerned that support for strategic science suffers from uncertainties over where Research Council and Departmental responsibilities lie. Research Councils fund such science where it relates to a high priority scientific need. Government Departments also have national need requirements in relation to policy or regulatory objectives, which may or may not equate with the scientific need requirement. Whilst Departments are generally good at identifying and funding their short-term applied needs, with some notable exceptions they are less good at analysing and making provision for their more strategic long-term requirements. The situation could arise therefore where there might be a national need for scientific advice which could not be satisfactority fulfilled because the underpinning science, which has not been of high scientific priority, had not been supported.

18. The failure to implement the Rothschild proposal that all Research Council research commissioned by Government should carry a 10 per cent strategic research addition is part of the problem. Another aspect is the pressure on Departments to support their specific short-term needs at the expense of their long-term requirements. We believe that the nation's need would be better served by all strategic research funding going direct to the Research Councils rather than through the Departments.

NATIONAL STRUCTURES FOR S&T ADVICE AND SUPPORT

19. These aspects were reviewed in detail in the Council's evidence to the House of Commons Select Committee. The main points may be summarised as follows:

- Action is needed to ensure close co-ordination at the interface between support for the science base and support through Departmental programmes, and at the interface within the science base between Research Councils and the Higher Education Funding Councils (HEFCs).
- There is a continuing need for a body to provide independent advice to Government on its longer term strategic aims in supporting S&T. This should be separate from the structures with executive responsibility for delivery of research and training. A reconstituted and smaller Advisory Council on Science and Technology (ACOST) with a majority of independent members able to make a regular commitment of time to its activities (of the order of one to two days per week) could fulfil such a role. The wider responsibilities of the present ABRC in terms of advising Government on civil science, the balance between national and international activity, etc., should be transferred to such a body.
- The present ABRC should be replaced by a Board for the Science Base (BSB) involving the Research Councils and HEFCs in partnership. This Board would address the interface between Research Councils and HEFCs and have responsibility for the maintenance and delivery of a healthy science base.
- The interface between Research Councils and Departments should be strengthened by ensuring full representation of appropriate Research Councils on Departmental Advisory Bodies, which would need to be created in certain cases. This would mirror the present system of full membership of Departmental Chief Scientists on Research Councils as appropriate.
- OST should develop a mechanism for bringing together all the S&T bids entering the PES process so that their inter-relationships and relative priorities may be assessed. This mechanism should be transparent, at least to the major players.

RESEARCH COUNCILS AS FUNDING AGENCIES

20. We are already moving towards a position where **providers of research**, HEIs, RCIs, and Government Research Establishments (GREs), **are all able to compete on level terms** (albeit with different types of skills, support and experience) for research and survey commissioned by Government and supported by the Research Councils. NERC supports this strategy. Moving further down that line suggests that RCIs should be given greater independence to exploit the new opportunities that will be available to them.

21. NERC has already devolved many management aspects from the centre to its institutes and is now requiring all new programme proposals from institutes to be subject to the same level of assessment as proposals from HEIs and elsewhere. A full devolution of RCIs, to Agency status for example, would need to ensure in some way that strategically important longer term research, observation, and survey programmes did not suffer; that important, but currently unfashionable, science was not neglected; and that nationally important infrastructure support, and valuable environmental databases were protected and sustained.

22. We believe therefore, that even within a fully devolved system of S&T, **there would still be a need to retain Research Councils as procurers of research and survey**. In this scenario the Councils would be responsible for developing and maintaining the strategic overview of future scientific opportunities and challenges in their respective areas, and be the customers (not providers) for basic and strategic research and survey. Were, (as suggested in para 18), the Councils to be given responsibility and funding allocations to cover the whole of Government's strategic research requirements, the identification of future opportunities would of course need to take account of Departmental as well as scientific needs.

Memorandum submitted by the Royal Society of Chemistry (27 November 1992)

The White Paper on Science and Technology

A contribution from The Royal Society of Chemistry

8. KEY POINTS

1. Chemistry is one of the three core scientific disciplines and it underpins many of the advances achieved in other science areas and improvements in the quality of our lives.

2. The success of the UK chemical and pharmaceutical industries is based on sustained investment in R&D—but this will only be possible in future if the UK has a strong home science base. This is currently at risk.

3. Chemistry's contribution to solving environmental problems is vital—and will be in growing worldwide demand.

4. To maintain a healthy science base, the public funding of basic research is essential. Such research stems from individual creativity and often leads to important advances in unexpected and unforeseen directions. Industry does, and should, take the lead in support of market-led research.

5. The proportion of funding for chemistry is under pressure—SERC spends only 10 per cent of its budget on chemistry—and yet chemistry does more for the UK industrial base than the bigger proportions spent in other areas of science.

6. The Government's advisory structure for science must be clear, simplified, open and accessible. It is essential that the Minister be involved in overall strategic decision-making and have the power to review plans for science spending by all other Government Departments.

7. International collaboration and major projects should be funded as a separate element; adverse currency fluctuations affect the UK's subscription costs and this in turn has led to unplanned budgetary cutbacks of smaller-scale UK research (especially in chemistry).

8. The perceived status of science and scientists must be raised and career scientific researchers properly remunerated.

1. INTRODUCTION

The Royal Society of Chemistry is the learned society and professional qualifying body for chemists in the UK. It has over 43,000 members; 65 per cent of employed members in the UK work in industry, 17 per cent in government-related activity and 18 per cent in higher education including universities. The Society welcomes the establishment of the OST and the opportunity to contribute to the preparation of the proposed White Paper. This contribution, which has been prepared after discussion with the Society's Scientific Affairs Board, is submitted by the Honorary Officers on behalf of the Council of the Society. The Society would be prepared to undertake detailed studies of any aspect of future science policy which affects chemistry.

This submission tackles only those issues which are particularly important to chemistry, which is one of the essential triad of sciences, with physics and biology. Chemistry is a central discipline with many of the advances in biology and medicine being increasingly dependent on chemical research, as are advances in new materials. In addition, the contribution of chemistry to the solution of a wide range of environmental problems is critical.

Although the Society would not wish to comment directly on the business/financial aspects of industrial research, its large industrial membership enables it to address the questions of training in chemistry as well as the requirement for a flourishing research base as a source of new ideas.

In the UK the chemical industry contributes about 10 per cent of manufacturing industry's gross value added, is about 2.3 per cent of the GDP and is the manufacturing sector's number one export earner. In 1991 exports were valued at £13.8 billion and a net export surplus of almost £3 billion generated.

2. RELATIVE POSITION OF UK CHEMISTRY AND UK CHEMICAL INDUSTRY

It is frequently stated that the UK is less successful than competitor countries, such as the USA and Japan, in translating inventions to the market place. However true this may be of much of British industry, it is demonstrably untrue of the chemical industry, within which we include the pharmaceutical and agrochemical industries. The relative success of the chemical industry is based on a major investment in research within the industry (as a fraction of sales, R&D costs average about 5 per cent, with some sectors spending more than 12 per cent). However, this research investment is dependent upon the quality of the

UK science base and on the provision of highly trained specialists. The chemical industry requires trained research workers and it is an essential function of academic research to provide training in all branches of the subject. It does not follow that the research itself has to have industrial applications. We believe that the Science Board of the SERC is absolutely correct in giving top priority to research training and this is done most effectively in chemistry. Because of recent restrictions on the availability of money to purchase new state of the art equipment, the quality of this research training must remain a matter of concern. The record of UK academic research in chemistry is an excellent one, by any measure, but its position is in danger of being eroded by severe funding limitations.

3. Fundamental versus applied research

There are essentially three types of research—basic, strategic and applied. The Society view is that public funding of science should be devoted primarily to supporting fundamental research in the first two of these categories. Research which is close to the market should be supported directly by industry either in-house or by means of research contracts with universities. This does not preclude public expenditure on science by other major Government Departments such as the DTI, the DoE, the DoH, etc., being devoted more to the applied area.

Central planning of basic or fundamental research would be counter-productive—it is simply impossible to predict which precise areas of such research will ultimately prove commercially important. A major problem with the current Research Council situation is that really exploratory research in chemistry is being squeezed out by a combination of the demands for short-term relevance and the requirement to support large-scale installations, e.g., CERN. The current share of the SERC budget which is devoted to chemistry is only 10 per cent, whereas much larger percentages are spent on particle and astrophysics (30 per cent) and biology.

Unless the funding of curiosity-driven research can be protected, it would be dangerous to emasculate the dual-support system further by transferring more of the total science budget to the Research Councils. The Research Councils should limit their activity to determining the overall distribution of their funds to the major disciplines and leave the sub-division of the resources to the relevant community of academic researchers, relying on the well-developed peer review process.

4. National and international collaboration

There are some areas of science where the high cost, both in capital and operating terms, necessitates, the use of shared facilities. Although this is much more common in disciplines other than chemistry, there are significant areas of chemistry which do need such large-scale facilities and, in general, the arrangements for European co-operation are satisfactory. There is a much better case for European co-operation in large-scale facilities than for some other European Community Framework programmes. Some international agreements are the subject of inter-governmental agreements and cannot be controlled entirely by the Research Councils and in such cases the international subscriptions should be a separate element in the funding package. In the present system, large swings in international subscriptions, often caused by currency fluctuations, always seem to result in even larger swings in smaller scale research budgets.

If Europe is to compete with Japan and the USA in research, it is essential that a common scientific culture is developed. For this reason, European Community support of research fellowship exchanges and of high level scientific conferences should be encouraged.

5. The advisory structure for science

The present advisory structure, ACOST, ABRC, Research Councils, Government Departments is a maze of unecessary complexity. Consideration should be given to merging elements of the current structure such as ACOST and ABRC. The advisory role should be two-fold: to enable decisions to be made on the distribution of funds into basic and strategic research and into the major disciplinary areas, and to assess the long-term benefits derived. Improved methods of monitoring and evaluating the output of the system need to be established. If science is to achieve the higher priority within the Government that recent changes have indicated, then direct Ministerial involvement in the main strategic decision-making process is essential and should include the power to review the science spending plans of other Government Departments. It is important that any simplified advisory structure should operate as openly as possible so that the scientific community is quickly made aware of the basis of its conclusions.

6. Status of scientists

In recent years the perceived status of many professionals, including scientists and teachers, has declined. The establishment of the Office of Science and Technology and the publication of the proposed White Paper are significant steps towards improving the status of science and scientists. Adequate remuneration of academic scientists will ensure that university training in the UK is maintained at a high standard. This in turn will contribute to the maintenance of a leading position for UK chemists and the chemical industry in the world scientific community.

7. OVERVIEW

The results of chemical research can readily be converted into commercial products in a wide range of industries, not only the chemical industry. However, the public funding of civil research in the UK is less as a percentage of GDP than is that of our major competitors, such as Japan and Germany, and, within that science funding, the proportion devoted to chemistry is under pressure. It is basic chemistry which underpins many improvements in the quality of life. A greater share of resources must be allocated to chemistry in the UK if its position in the international arena is to be maintained, let alone improved.

Supplementary memorandum submitted by the Medical Research Council (27 November 1992)

ACOST contribution: White Paper on Science and Technology

MRC COMMENTS

1. We are in sympathy with many aspects of the ACOST submission including their account of the role of Government in research and development, the enhanced role they propose for the CSA, their comments about education in science and technology at post-16 and degree course levels, and the proposals for reform in the arrangements for baseline funding of universities.

2. However, in two important and fundamental respects we part company with the ACOST submission. These are the proposals that:

- Public funding for curiosity driven research should be distinguished from funding for mission driven research.
- Separation of ownership of research institutes from the funding bodies can be applied as a universal principal.

3. ACOST present a false distinction between "research driven by the curiosity of researchers" and "mission-orientated research driven by it relevance to the needs of customer/users". We believe this both misreads the motivation and intellectual processes of research workers and sets up a barrier to the application of research. Researchers are not immune to the needs of the society in which they live and customers/users cannot commission successful research programmes without engaging the curiosity of researchers. A funding structure which links basic research with missions facilitates the two-way interactions between basic and applied research. We have argued in our own submission that in medical research there is world-wide agreement that what is needed is to integrate the basic biological sciences with clinical medicine. We believe this applies to science overall. We need structures that encourage and enhance this integration, not structures that will deepen the divide.

4. Separation of funding bodies and providers is a principle which has proved useful in a wide variety of circumstances.

Its application to research institutes needs however to be approached with caution. In our view we support two of the "world-class research institutes" referred to by ACOST in section 2 of their report: the National Institute for Medical Research and the Laboratory of Molecular Biology. We need to ensure that any change in the status of these institutes will not place the quality of their research output at risk. No mention is made in the report of the Council's research units which we set up in areas of science neglected by the university system because they cross traditional disciplinary boundaries or are in new fields. Units have therefore arisen from MRC initiatives and have provided a catalyst to new developments in the universities (where 40 of the Council's 45 units are embedded). They are too small for privatisation to be considered a realistic option.

5. The MRC approach to institutes and units leads to more effective financial accountability and more efficient management in basic and strategic research areas where a fundamental objective is to advance knowledge. In such cases it is not possible to define targets with sufficient precision to draw up effective contract mechanisms for funding. (In our own submission to the Chancellor we have argued that by contrast the MRC Collaborative Centre is engaged in applied work on a contract basis funded by industry. In this case the MRC has judged that more independent (private company) status will yield the best results.) Our experience of block grant funding of independent research establishments confirms us in this view. There are real risks of a gradual divergence of the strategic scientific interests of funder and research establishment leading to a mutual loss of confidence. In these circumstances cutting research funding is a crude—and ineffective—instrument for reshaping scientific structures and programmes.

Other advantages of the MRC owning its own institutes and units are:

- A unified career structure for both research scientists and support staff.
- The ability to absorb lumpy items of capital expenditure, especially for new equipment, within a Council-wide budget.
- The ability to address research strategy issues highlighted by activity in an institute or units within a national framework. Examples would be the major expansion of the neurobiology programme headed by Dr Nigel Unwin at the Laboratory of Molecular Biology and the initiative in developmental biology at the National Institute for Medical Research.
- The ability presented by an in-house research capability to change attitudes to technology transfer.

6. Are these advantages outweighed by other considerations? The ACOST report makes considerable play of the fact that research institutes and units enjoy "protected access" to funds. Within the MRC there is no such protected access. Institute and unit programmes are considered in direct competition with grant applications from HEIs. The reviewers are independent scientific advisers, the majority drawn from HEIs, and they make assessments of grant and institute/unit work on the same criteria and rank them in priority order. Such peer review judgments led, for example, to the MRC's decision to close the Clinical Research

Centre (an institute employing some 500 staff in the late 1980s) and to redeploy the resources to fund the Clinical Research Initiative. In this situation (and when units are closed) the Council has a responsibility to manage the closure process and this leads to a carefully managed run-down with the best researchers and teams being protected and redeployed. In our view the peer review system provides the protection that ACOST is seeking. The "privatisation" of MRC institutes and units would not in our view be in the national interest.

ABRC SUBMISSION: SCIENCE AND TECHNOLOGY

MRC COMMENTS

In broad terms we support the proposals in the ABRC submission. Whilst there are differences in emphasis and detail between what the MRC has put forward to the Chancellor and what the ABRC has proposed, there is broad agreement on the main points of principle.

Letter to the Clerk of the Committee from Professor Graeme Davies, Chief Executive, HEFCE (27 November 1992)

WHITE PAPER ON SCIENCE AND TECHNOLOGY

Thank you very much for giving us the opportunity to offer some comment on the advice submitted to the Chancellor of the Duchy of Lancaster by the ABRC and ACOST.

I attach, by way of response, a copy of our own submission to Mr Waldegrave.[1] This has now been endorsed by the HEFCE, and is being sent to the OST today.

We had not originally envisaged making this submission public, but in view of the decision by the ABRC and the individual Research Councils to release their own submissions, we now intend to publish our advice.

As you will see, there are some important areas where the HEFCE's views diverge markedly from those of the ABRC. In particular, the Council's unequivocal view is that there are strong positive advantages in the present system, and we do not accept the arguments for further changes in the organisation of research funding in higher education which are advanced by the ABRC.

Our response largely speaks for itself. We would however emphasise the following:

(a) The argument that the shift in the dual support boundary which is now taking place is in itself an argument for agreeing to further changes is weak. We believe that any such change would have to be considered on its merits, and our paper argues that no such change should take place. We find it difficult to understand the use of the term "level playing field" in describing the ABRC arguments.

(b) There may be advantages in the Research Council seeking to adopt a more strategic deployment of funds and the allocation of the individual research grants currently allows. However we consider that the allocation of longer term support based on the careful assessment of outputs is precisely the approach taken by the HEFCE and its sister Councils, care would need to be taken to ensure that the ABRC did not simply replicate the allocation procedures of the Funding Councils. The same arguments could be used to propose that the funding councils should take on the role of the research councils, rather than vice versa.

(c) A plurality of sources of funding has many advantages, and these are set out in our paper. They must not be lost.

(d) For the reasons set out in our paper, we would oppose any transfer of resources from the Funding Councils to the Research Councils in respect of the research costs involved in the training of post-graduate research students. No arguments are adduced in support of this proposal, and we could equally argue for a transfer of funding in the opposite direction. Similarly, we see no case for transferring from the Research Councils to the HEFCs funds paid in the form of college fees to those universities which charge them. Both changes would be disruptive without bringing any obvious benefits. We do however believe that there is scope for collaboration between the ABRC and the Funding Councils in this area, and you will see in paragraph 19 of our submission that we propose a joint study.

(e) The individual research councils are currently very fully involved in our research assessment exercise through membership of assessment panels. However we would also be very happy to explore ways of further involving the ABRC in the Funding Councils' research assessment procedures.

(f) As regards the ACOST proposal that the funding for research currently held by the DFE should be transferred to OST, we would strongly oppose this and draw attention to the points made in section E of our submission.

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[1] Not printed.

Supplementary memorandum submitted by the Agricultural and Food Research Council (27 November 1992)

INTRODUCTION

1. The main differences between advice from ABRC and ACOST to the Chancellor of the Duchy of Lancaster are in the key areas of:
   - The structure of the research funding system.
   - The relationship between funding bodies and institutions undertaking research (research providers).

These issues are central to the arrangements for promoting publicly-funded S&T. The future health of the innovative science base, of the training of scientists and engineers and of technology transfer depends on them. Yet the views of ABRC and ACOST are currently diametrically opposed. It is important that these differences are debated so that policy advisers in OST and the Chancellor of the Duchy of Lancaster himself may be fully informed.

RESEARCH FUNDING SYSTEM

2. ACOST argue for three separate funding channels differentiated by the *nature* of S&T—curiosity driven, mission oriented and experimental development. This would lead to separate research council-like structures—the Council for the Advancement of Scientific Knowledge (CASK) and the Council for Mission Oriented Research (CMOR). Experimental development would, as present, have a multiplicity of customers, mainly Government departments and industry.

3. ABRC, on the other hand, stress the importance of not impeding the movement of ideas and people between basic, strategic and applied research. The Board argues cogently for a structure of funding bodies based on missions which provide a purposeful focus and clear objectives without unhelpful demarcation by scientific disciplines or by the nature of the research activity.

4. AFRC's experience of research funding and technology transfer suggests that the ACOST recommendations are unsoundly based and could have a serious adverse effect on the transfer of innovation and people from the science base to industry. The advice seems to be predicated on the dated linear model of technology transfer in which interaction between industry and the science base normally occurs through applied or mission-oriented research. Nothing could be further from the truth.

5. The range of AFRC's technology transfer mechanisms includes special relationships with three key British biotechnology companies (10 per cent of this small but crucial section of industry. Animal Biotechnology Cambridge Ltd, Agricultural Genetics Co Ltd (AGC) and Pharmaceutical Proteins Ltd. All have access on agreed commercial terms to key areas of AFRC's Science and Budget-funded work in three institutes (Institute of Arable Crops Research, Institute of Animal Physiology and Genetics Research and Institute of Plant Science Research). As well as commercialising AFRC discoveries in animal embryo technology, plant biotechnology and transgenic animal technology, these companies are an important source of research funds. AGC alone has invested £9 million over the past 10 years in institutes funded by AFRC.

6. Biotechnology companies depend on scientific innovation. These three companies interact with the more basic areas of AFRC's Science Budget programmes, notably cell and molecular biology and genetic studies. Such links promote rapid and effective technology transfer. These relationships illustrate that innovation occurs unpredictably in the continuum of science. Consequently AFRC seeks continuous interaction between all aspects of its science and industry—with the small biotechnology companies described above, with larger, established companies and, for some technical information, direct with farmers' organisations. Separating the funding arrangements for basic research and postgraduate training from those of mission-oriented research, as proposed by ACOST, seems likely to set back the flow of ideas and people on which advances in S&T and technology transfer depend.

7. AFRC believes that technology transfer and industrial competitiveness would be seriously disadvantaged by creating a backward-looking separation of responsibilities for funding curiosity driven (basic) research and mission-oriented (strategic and applied) research. Innovation can occur at all points in the continuum; for instance, developments in the biological sciences cell and molecular biology are currently creating major opportunities for industry. The Council strongly supports a research funding structure based on mission-led research councils, as recommended by ABRC. As now, advice on strategic developments and broad resource allocation should be provided by an overarching Board.

RELATIONSHIPS BETWEEN RESEARCH FUNDERS AND PROVIDERS

8. ACOST perceive disadvantages in funding bodies such as research councils controlling or, in some cases, owning research institutes. The Council recommends that research providers, including research council institutes (RCIs) should be placed on a level playing field and no longer enjoy "protected access" to funding bodies. The eventual goal should be the privatisation of the majority of publicly-owned laboratories.

9. ABRC, in contrast, sees RCIs as an essential delivery mechanism for the Government's S&T strategy which should not be distanced from the science base. RCIs are characterised by long-term scientific planning, close management and stringent internal review and external evaluation. As such, RCIs allow research councils to integrate strategic science across each council's mission and to redirect S&T effort in response to both scientific opportunity and social, political and industrial needs. AFRC operates devolved management control of RCIs in combination with clear monitoring procedures and accountability.

10. The ACOST view of RCIs seems to be based on the mistaken assumption that "ownership" means that RCIs have an undue and unwelcome influence on research councils' strategic thinking and allocation of resources. Moreover, in recommending their distancing from research councils and eventual privatisation, the Council seem not to appreciate the benefits of properly managed RCIs in a mixed economy comprising large strategic research institutes, smaller research units and groups within HEIs and individual HEI research workers supported by responsive mode grants. All have a part to play if the science base is to strike the right balance between flexibility and stability.

11. Nor does the ACOST analysis stand up to examination against the reality of RCIs in the AFRC's own mixed economy. Five of the RCIs supported by AFRC are independent bodies—in the main companies limited by guarantee with charitable status. Some are backed by independent charitable trusts. All five have their origins in funding initiatives by forward-looking farmers. They predate AFRC, some by several decades. The remaining two institutes, dealing with animal physiology research and with food research, are owned by AFRC. They were set up in the late 1930s and 1960s respectively and are examples of public funding in response to market failure.

12. Each institute has a mission. Its programme is subject to rigorous appraisal, monitoring and evaluation by AFRC. There is an annual project turnover target of 10 per cent. The five independent institutes have Boards of Directors with a mix of scientific and industrial expertise. The two AFRC institutes have advisory bodies with similar compositions. Each institute makes a distinctive contribution to AFRC's strategic scientific objectives. At a strategic planning level, AFRC progressively moves resources between institutes to match new scientific opportunities and to provide new laboratories and other facilities. Many programmes span two or more institutes and all institutes collaborate extensively with HEIs. Generic scientific advances in one institute, say in plant genetics, are swiftly transmitted to programmes on crops in other institutes.

13. As for funding, each institute receives core funding and co-ordinated programme funding from AFRC's Science Budget funds. Levels of core funding are determined annually by Council after rigorous and transparent assessment of *all* scientific plans (in RCIs and HEIs) by research committees made up of leading members of the research community, industrialists and Government officials. There is no inside track for institute directors.

14. Co-ordinated programmes, the other limb of institute Science Budget funding, are funded on a project basis in competition with HEIs. Project proposals from each sector, costed on the same basis to create a level playing field, are appraised by scientific peers. The proportion won by the RCIs depends quite simply on scientific merit.

15. In terms of strategic resources, a formal relationship between a research council and the institutes it funds is vital. Capital project funds can be directed by a research council with great effect to provide costly new facilities or to refurbish existing laboratories on a scale and at a price that a free-standing RCI could not manage. It is difficult to envisage how the repositioning of the network of AFRC-supported institutes during a ten-year period of restructuring (1982-92) could have been achieved if it had depended on the aggregate of a series of independent decisions and financial investments by a diversity of free-standing institutes.

16. Finally, AFRC's track record firmly contradicts the argument of protected access to funds by RCIs used by ACOST. Compare AFRC's funding of institutes and HEIs over the past 10 years during which the Council not only restructured the institute base but also switched Science Budget funding towards HEIs in a major way:

AFRC Science Budget funding by sector

	1983-84	1993-94 (planned)
HEIs	8	36
Institutes	62	52

(£ million at 1993-94 prices—using GDP deflators)

17. For strategic planning of science and for value for money in capital investment, AFRC strongly supports the ABRC view that RCIs are an essential delivery mechanism for the science base. Distancing from funding bodies would lead to the fragmentation of integrated scientific strategies and facilities. There would be unproductive competition involving the retention rather than sharing of scientific knowledge and technology. AFRC's own record over the past decade directly contradicts ACOST's worries about protected access to research council funds. As far as HEI costing procedures allow, within AFRC there is a level playing field for research assessment and funding.

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